Anatoly T. Fomenko

History: Fiction or Science?

CHRONOLOGY 3

Entities should not be multiplied beyond necessity.

FRIAR WILLIAM OCKHAM
(allegedly 1285–1349)

Ptolemy is by no means the greatest astronomer of the antiquity,
but … the most successful con man in the history of science.

ROBERT R. NEWTON
American astrophysicist
(1919-1991)

A. T. Fomenko
Chronology 1
Introducing the problem. A criticism of the Scaligerian chronology.
Dating methods as offered by mathematical statistics. Eclipses and zodiacs.

A. T. Fomenko
Chronology 2
The dynastic parallelism method. Rome. Troy. Greece. The Bible. Chronological shifts.

A. T. Fomenko, T. N. Fomenko, V. V. Kalashnikov, G. V. Nosovskiy
Chronology 3
Astronomical methods as applied to chronology. Ptolemy's *Almagest*.
Tycho Brahe. Copernicus. The Egyptian zodiacs.

A. T. Fomenko, G. V. Nosovskiy
Chronology 4
Russia. Britain. Byzantium. Rome.

A. T. Fomenko, G. V. Nosovskiy
Chronology 5
Russia = Horde. Ottomans = Atamans. Europe. China. Japan. The Etruscans. Egypt. Scandinavia.

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Chronology 6
The Horde-Ataman Empire. The Bible. The Reformation. America. Passover and the calendar.

A. T. Fomenko, G. V. Nosovskiy
Chronology 7
A reconstruction of global history. The Khans of Novgorod = The Habsburgs. Miscellaneous information.
The legacy of the Great Empire in the history and culture of Eurasia and America.

This seven volume edition is based on a number of our books that came out over the last couple of years and were concerned with the subject in question. All this gigantic body of material was revised and categorized; finally, its current form does not contain any of the repetitions that are inevitable in the publication of separate books. All of this resulted in the inclusion of a great number of additional material in the current edition – including previously unpublished data. The reader shall find a systematic rendition of detailed criticisms of the consensual (Scaligerian) chronology, the descriptions of the methods offered by mathematical statistics and natural sciences that the authors have discovered and researched, as well as the new hypothetical reconstruction of global history up until the XVIII century. Our previous books on the subject of chronology were created in the period of naissance and rather turbulent infancy of the new paradigm, full of complications and involved issues, which often resulted in the formulation of multi-optional hypotheses. The present edition pioneers in formulating a consecutive unified concept of the reconstruction of ancient history – one that apparently is supported by a truly immense body of evidence. Nevertheless, it is understandable that its elements may occasionally be in need of revision or elaboration.

Anatoly T. Fomenko, Tatiana N. Fomenko,
Vladimir V. Kalashnikov, Gleb V. Nosovskiy

History: Fiction or Science?

CHRONOLOGY

3

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History: Fiction or Science?

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Fomenko, Tatiana Nikolaevna (*b. 1948*). Mathematician, Candidate of Physics and Mathematics, author of books and scientific articles on algebraic topology and geometry, theory of algorithms, faculty member of computational mathematics and Cybernetics of MSU. Worked as researcher in University of British Columbia, Canada; held courses of topology and applications in 1991.

Kalashnikov, Vladimir Viatcheslavovich (1942-2001). Doctor of Physics and Mathematics, professor. Specialist in applied statistics theory. V. V. Kalashnikov was an authority on mass queuing models, reliability, risk, imitation modelling of stochastic systems. In particular he developed criteria and estimates of stability, perturbation of various probabilistic processes. Author of 160 scientific publications, including 10 monographs. V. V. Kalashnikov was distinguished with the USSR State Reward in 1986 for his works on modelling and simulation.

Nosovskiy, Gleb Vladimirovich (*b. 1958*). Candidate of Physics and Mathematics (MSU, Moscow, 1988), specialist in theory of probability, mathematical statistics, theory of probabilistic processes, theory of optimization, stochastic differential equations, computer modelling of stochastic processes, computer simulation. Worked as researcher of computer geometry in Moscow Space Research Institute, in Moscow Machine Tools and Instruments Institute, in Aizu University in Japan. Faculty member of the Department of Mathematics and Mechanics MSU.

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Also by Anatoly T. Fomenko

(List is non-exhaustive)

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Plenum Publishing Corporation. 1987. USA, Consultants Bureau, New York and London.

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Chapter 2 **A preliminary analysis of the Almagest star catalogue**

Chapter 3 **Unsuccessful attempts of dating the Almagest. Reasons for failure. Our new approach and a brief account of our results**

Chapter 10 **Additional considerations concerning the dating of the Almagest. Stellar coverings and lunar eclipses**

by A. T. Fomenko, G. V. Nosovskiy

Chapter 11 **Other problems and hypotheses arising from the dating of the Almagest catalogue**

by A. T. Fomenko, G. V. Nosovskiy

Part 2: THE DATING OF THE EGYPTIAN ZODIACS

by A. T. Fomenko, T. N. Fomenko, G. V. Nosovskiy

From the Publishers

History: Fiction or Science? contains data, illustrations, charts and formulae containing irrefutable evidence of mathematical, statistical and astronomical nature. You may as well skip all of it during your first reading. Feel free to use them in your eventual discussions with the avid devotees of classical chronology. In fact, before reading this book, you have most probably been one of such devotees.

After reading ***History: Fiction or Science?*** you will develop a more critical attitude to the dominating historical discourse or even become its antagonist. You will be confronted with natural disbelief when you share what you've learned with others. Now you are very well armed in face of inevitable scepticism. This book contains enough solid evidence to silence *any historian* by the sheer power of facts and argumentation.

History: Fiction or Science? is the most explosive tractate on history ever written – however, every theory it contains, no matter how unorthodox, is backed by solid scientific data.

The dominating historical discourse in its current state was essentially crafted in the XVI century from a rather contradictory jumble of sources such as innumerable *copies* of ancient Latin and Greek manuscripts whose originals had *vanished* in the Dark Ages and the allegedly *irrefutable* proof offered by late mediaeval astronomers, resting upon the power of ecclesial authorities. Nearly all of its components are blatantly untrue!

For some of us, it shall possibly be quite disturbing to see the magnificent edifice of classical history to turn into an ominous simulacrum brooding over the snake pit of mediaeval politics. Twice so, in fact: the first seeing the legendary millenarian dust on the ancient marble turn into a mere layer of dirt – one that meticulous unprejudiced research can eventually remove. The second, and greater, attack of unease comes with the awareness of just how many areas of human knowledge still trust the elephants, turtles and whales of the consensual chronology to support them. Nothing can remedy that except for an individual chronological revolution happening in the minds of a large enough number of people.

Anatoly T. Fomenko, Tatiana N. Fomenko,
Vladimir V. Kalashnikov, Gleb V. Nosovskiy

Chronology 3

Third volume of *History: Fiction or Science* series

Astronomical methods in chronology
Ptolemy's Almagest
Tycho Brahe
Copernicus
Egyptian zodiacs

Foreword

This book is dedicated to the new trend in science associated with the development and use of independent natural scientific methods for the dating of the ancient and mediaeval historical events. It is the follow-up to the first two books in the series, Chron1 and Chron2 by Anatoly Fomenko. In the present volume (Chron3) we date archaeological artefacts and historical texts by their astronomical content.

The problem of independent dating as applied to historical chronology has got a long history. The idea of applying the methods of natural science for this purpose is also far from novel. However, A. T. Fomenko, accompanied by a group of mathematicians and physicists from the Moscow State University, was the first to construct a systematic chronology from scratch using nothing but natural scientific methods completely unrelated to the Scaligerian chronological scale. This was done in the early 1980's. In order to distinguish between our chronology (constructed with the aid of natural scientific methods and nothing but) and the consensual chronology of Scaliger and Petavius, we have called the former "New Chronology".

The first part of the present book is based on the work of A. T. Fomenko, V. V. Kalashnikov and G. V. Nosovskiy entitled "The Dating of the Almagest Star Catalogue", which came out in 1995 ([METH3]:1 and [METH3]:2), and was subsequently revised in 2000 ([METH3]:3). This book was revised yet again for the present edition, and substantially so, with important new material added.

The second part of the book deals with the new datings of the Egyptian horoscopes. We are referring to the monumental bas-reliefs discovered in the temples of the "ancient" Egypt, which depict zodiacal constellations and planets (horoscopes, in other words). They are all dated to deep antiquity today. However, modern astronomy permits a different and more precise dating. It turns out that each and every "ancient" Egyptian horoscope that we found yields a dating of XII-XIX century A.D., no less. For instance, the astronomical datings of the "ancient" Egyptian horoscopes from the temples of Dendera and Esna (Latopolis) unequivocally refer to the epoch of the XII-XV century. Apparently, some of the Egyptian constructions that are dated to deep antiquity today were in fact built in the late Middle Ages.

The book also contains a number of annexes.

Let us provide a brief synopsis of the present volume's contents.

The first part of the book deals with the famous problem of solving the star catalogue from Ptolemy's Almagest.

The Introduction contains a concise overview of the Almagest's contents, as well as certain information concerning the Almagest catalogue and a number of other star catalogues. We explain why the problem of dating old star catalogues is of interest to us, and cite information about mediaeval astronomers associated with the creation of star catalogues.

Chapter 1 is a collection of important facts related to astronomy, astrometry, the history of astronomi-

cal instruments and the methods of measuring star coordinates.

Chapter 2 contains a preliminary analysis of the Almagest star catalogue. We discuss a plethora of corresponding problems such as ambiguous star identification and certain anomalies pointed out by researchers earlier, such as the Peters sinusoid. We also discuss the issue of latitude and longitude precision in the Almagest catalogue.

In Chapter 3 we analyse possible datings of the Almagest star catalogues based on standard methods and ideas. We demonstrate that it is impossible to date a catalogue by more or less standard and elementary methods, pointing out the principal difficulties that require a substantially more refined method. We analyse a number of known works for this purpose, whose authors attempted to confirm the traditional dating of the Almagest catalogue by proper star motions, exposing the reasons why they failed.

At the end of Chapter 3 we describe the conception of our star catalogue dating method.

In Chapter 4 we identify fast stars as the stars mentioned in the Almagest catalogue. Obviously enough, such identification isn't always possible. Moreover, it depends on the alleged dating of Ptolemy's observations in general. The same fast star whose position on the celestial sphere changes over the years can be identified as several stars from the Almagest catalogue. This effect is important. A failure to comprehend it has already led several authors (such as Y. N. Yefremov and Y. A. Zavenyagin) to erroneous datings of the Almagest catalogue.

Chapter 5 contains mathematical results used in the statistical analysis of star catalogues. We classify various catalogue discrepancies and discuss various methods of discovering the latter and compensating the systematic compound.

Chapter 6 contains the results of our global statistical calculations involving the entire Almagest star catalogue as well as its parts. The discovered statistical characteristics of different parts of the Almagest has made it feasible to find the "well-measured" and "poorly measured" regions of the celestial sphere. We have discovered that the Almagest star atlas could be divided into uniformity regions whose stellar coordinate precision differed drastically from each other. This gives us a new understanding of the Almagest structure and allows us to develop a method of dating the catalogue.

In Chapter 7 the Almagest star catalogue is dated by two independent methods: statistical and geometric. Both give us the same result – apparently, Ptolemy's observations cannot predate 600 A.D. or postdate 1300 A.D., insofar as the Almagest star catalogue is concerned (or its oldest part at the very least). Other parts of the Almagest could be written much later, which must indeed be the case, as we demonstrate in the chapters to follow.

In Chapter 8 we explain the mysterious "Peters sinusoid" and also analyse the value of the angle between the equatorial and the ecliptic plane as cited in the Almagest.

In Chapter 9 we research and date other famous old catalogues by Tycho Brahe, Ulugbek, Hevelius and Al-Sufi. These catalogues illustrate the method we suggest; the results are discussed.

Chapter 10 was written by A. T. Fomenko and G. V. Nosovskiy. It considers the possibility of dating the Almagest by other astronomical observation data that it contains apart from the Almagest. The results are in complete concurrence with our dating of the Almagest star catalogue. We restore the "Ptolemaic chronology", or the chronological ideas adhered to by Ptolemy himself or the XVI-XVII century editors of his books. These ideas were subsequently forgotten due to the erroneous conversion of the Ptolemaic dates into their "A.D." equivalents inherent in Scaligerian chronology.

In Chapter 11, also written by A. T. Fomenko and G. V. Nosovskiy, we discuss many other problems associated with the dating of the Almagest in general.

The second part of the book was written by A. T. Fomenko, T. N. Fomenko and G. V. Nosovskiy; it describes the new method of dating the Egyptian zodiacs. The method is used to date the "ancient" Egyptian zodiacs from the temples of Dendera and Esna, as well as the horoscopes discovered inside Egyptian tombs. All the dates turn out mediaeval and pertain to the XII century A.D. the earliest.

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Part 1

THE DATING OF THE ALMAGEST

A. T. Fomenko, V. V. Kalashnikov, G. V. Nosovskiy

Introduction

1. A BRIEF DESCRIPTION OF THE ALMAGEST

The Almagest is the famed mediaeval oeuvre that deals with astronomy, spherical geometry and calendar issues. It is believed to have been written by Claudius Ptolemy, an astronomer, mathematician and geographer from Alexandria. Historians date his lifetime to the II century A.D. We shall cite some brief information about Ptolemy below. However, one must instantly point out that, according to certain specialists in the history of astronomy, "Likewise his works, the personality of Ptolemy was treated rather strangely by history. His contemporaries have left no historical records of either his life or his endeavours … We don't know so much as the approximate dates of Ptolemy's birth and death or indeed any other details of his biography" ([98], page 6). Figs. 0.1, 0.2, 0.3, 0.4, 0.5 and 0.6 reproduce ancient portraits of Ptolemy.

According to Scaligerian chronology, the Almagest was created in the reign of the Roman emperor Antoninus Pius, who reigned in 138-161 A.D.

Let us instantly point out that the very literary style of the epoch, which is at times excessively grandiloquent and meandering, is more likely to hail from the epoch of the Renaissance than "deep antiquity", when paper and parchment (let alone books) were luxuries. See for yourselves – the Almagest begins like this.

"O Sire, it appears to me that the true philosophers made the most laudable distinction between philosophy in theory and practice. Indeed, even notwithstanding earlier attempts to unite the two, one could always see a great difference between them. Firstly, although certain moral virtues might be possessed by a great multitude of uneducated people, no study of the ways of the Universe is possible without prior education. Secondly, the former benefit the most due to incessant activity, whereas the latter relish in the advancement of theoretical research. We therefore deem it necessary to let our mental conceptions control our actions most rigidly on the one hand, so as to refer to a perfect and elegant ideal all the time, and, on the other, to direct most of our energy towards familiarising ourselves with a multitude of exquisite theories and learning many more things pertaining to the discipline commonly referred to as mathematics in the narrow sense of the word … If we are to educe the primordial reason that has set the Universe in motion in the simplest form, it was the immanent and invisible God. The next section is theology … The section that studies the material and the ever-changing qualitative aspects such as whiteness, warmth, sweetness, softness etc., is called physics … Finally, the discipline concerned with the qualitative motions and shapes … can be defined as mathematics" ([704], pages 5-6).

The style is perfectly typical for late mediaeval scientific (or, as they are also called, scholastic) works of the XV-XVII century. One most vivid detail is the reference to an invisible and immanent God by Ptolemy – a characteristic element of the Christian dogma,

Fig. 0.1. Ancient drawing of Ptolemy dating from 1584. Ptolemy is holding a Jacob's rod. Thevet. Les vrais protr. et vies d'hommes illustres… Paris, 1584. Taken from [704], page 431.

Fig. 0.2. Ancient sculpture depicting Ptolemy from the cathedral of Ulm (around 1469-1474). The statue was made by Jorg Sirlin the Senior. Taken from [704], page 448.

Fig. 0.3. Ancient depiction of Ptolemy from the ***Global Chronicle*** by Hartmann Schedel. Augsburg, 1497. Taken from [90], page 25.

Fig. 0.4. Ancient portrait of Ptolemy, where he looks like a typical mediaeval European. Taken from [98], page 7.

quite alien to the polytheism of the Olympians. And yet Scaligerian chronology tries to convince us that Christianity only became the official religion in the IV century A.D., and the "ancient Greek Ptolemy" from the II century A.D. is clearly considered a pre-Christian author by the historical authorities.

We would like to introduce the reader to the Almagest's table of contents, given that this fundamental scientific oeuvre is hardly a popular read nowadays. According to the Scaligerite historians, it was written almost two thousand years ago.

It has to be pointed out that certain researchers consider the existing division of the Almagest into chapters to be more recent than the book itself, likewise the names of the chapters ([1358], pages 4-5). However, this fact is of no importance to us presently, since our only goal is to familiarise the readers with the structure of the Almagest.

Fig. 0.5. Ancient portrait of Ptolemy. Wood engraving, XVI century. Taken from [1160], page 25.

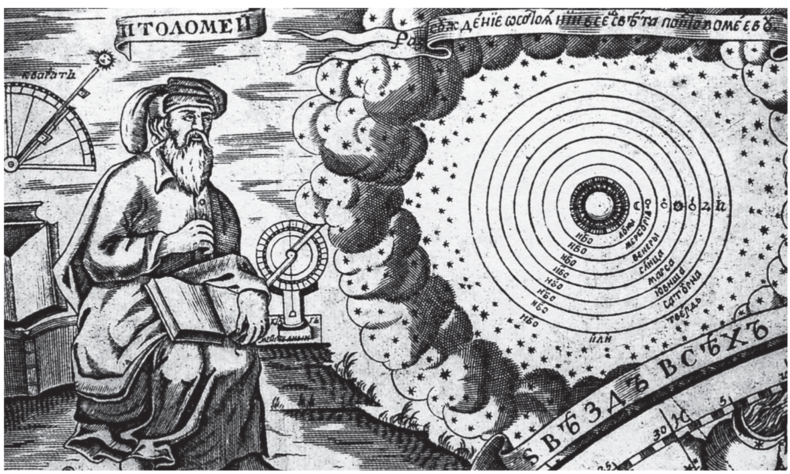


Fig. 0.6. Ancient drawing of Ptolemy on the "Cosmosphere" of Vassily Kiprianov, 1707. Ptolemy is wearing something that resembles an Ottoman turban. Taken from [90], page 212.

The Almagest: table of contents.

11. On the fact that the discrepancy between the lunar inequation value of Hipparchus and the one discovered by the authors results from calculations and not from a priori assumptions.

Volume 5.

1. On the construction of the astrolabe.
2. On the hypotheses of the double lunar inequation.
3. On the value of the lunar inequation that depends on the Moon's position in relation to the Sun.
4. On the proportion value of the lunar orbit's eccentricity.
5. On the "declination" of the lunar epicycle.
6. How to calculate the position of the Moon geometrically, relying on periodic movements.
7. Construction of the full moon inequation table.
8. The full moon inequation table.
9. On calculating the position of the Moon in general.
10. On the fact that the syzygy difference produced by the lunar eccentricity is marginal.
11. On the lunar parallax.
12. On the construction of the parallax instrument.
13. Estimating the lunar distances.
14. On the values of visible diameters of the Sun, the Moon and the shadow of the Earth in syzygies.
15. On the distance to the Sun and various implications of this calculation.
16. On the sizes of the Sun, the Moon and the Earth.
17. On individual values of solar and lunar parallaxes.
18. Parallax table.
19. Parallax definition.

Volume 6.

1. On the new moons and the full moons.
2. Compilation of the mean syzygy table.
3. New moon and full moon tables.
4. How to calculate the mean and the true syzygy.
5. On the limits of solar and lunar eclipses.
6. On the intervals between eclipse months.
7. The construction of eclipse table.
8. Eclipse tables.
9. Lunar eclipse calculations.
10. Solar eclipse calculations.
11. On the "eclipse declination" angles.
12. Eclipse "declination" table.
13. "Declination" definition.

Volume 7.

1. On the immobile stars, whose position in relation to one another never changes.
2. On the retrograde motion of the immobile star sphere alongside the ecliptic.
3. On the circular nature of the retrograde motion of the immobile star sphere around the ecliptic poles.
4. On the methods of compiling an immobile star catalogue.
5. Northern Hemisphere constellation catalogue.

Volume 8.

1. The Southern Hemisphere constellation catalogue.
2. On the position of the Milky Way's circumference.
3. On the construction of the cosmosphere.
4. On the configuration characteristic for the immobile stars.
5. On simultaneous ascensions, culminations and descents of immobile stars.
6. On the first and last moments of the immobile stars' visibility.

Volume 9.

1. On the order of the spheres of the Sun, the Moon and the five planets.
2. On the aims of our planetary hypotheses.
3. On the five planets returning periodically.
4. Mean longitudinal motion table and the anomaly of the five planets.
5. Primary postulations concerning the hypotheses of five planets.
6. On the character of the hypotheses and the respective discrepancies.
7. Estimating Mercury's apogee position and its movements.

8. How planet Mercury gets the closest to the Earth twice in one move.
9. On the size and proportions of Mercury's anomalies.
10. Mercury's periodic motion rectified.
11. On the epoch of Mercury's periodic motion.

Volume 10.
1. Estimating the apogee of Venus.
2. On the size of the planet's epicycle.
3. On the relations between the eccentricities of planet Venus.
4. On the amendment of the planets' periodic motions.
5. On the epoch of the periodic motion of Venus.
6. Preliminary data about other planets.
7. Estimating the eccentricity and the apogee of Mars.
8. Estimating the epicycle of Mars.
9. Rectification of the periodic motion of Mars.
10. On the epoch of the periodic motion of Mars.

Volume 11.
1. Estimating the eccentricity and the position of Jupiter's apogee.
2. Estimating the epicycle of Jupiter.
3. The amendment of its periodic motion.
4. On the epoch of Jupiter's periodic motion.
5. Estimating the eccentricity and the position of Saturn's apogee.
6. Estimating the epicycle of Saturn.
7. The amendment of its periodic motion.
8. On the epoch of Saturn's periodic motion.
9. How the periodic motion can be used for a geometric calculation of the true positions.
10. The construction of the anomaly table.
11. Tables for the estimation of the longitudes of the five planets.
12. On calculating the longitudes of the five planets.

Volume 12.
1. On the preliminary considerations concerning retrograde motion.
2. The calculation of Saturn's retrograde motion.
3. The calculation of Jupiter's retrograde motion.
4. The calculation of Mars's retrograde motion.
5. The calculation of Venus's retrograde motion.
6. The calculation of Mercury's retrograde motion.
7. Stationary point table construction.
8. Stationary point tables. Amended anomaly value.
9. Estimation of the maximal possible distances between Venus, Mercury and the Sun.
10. Tables of maximal distances between the planets and the true position of the Sun.

Volume 13.
1. On the hypotheses that concern the latitudinal motion of the five planets.
2. On the character of motion in the alleged inclinations and obliquities in accordance to the hypotheses.
3. On the size of the obliquities and inclinations.
4. The construction of tables for the individual values of longitudinal discrepancies.
5. Table for latitudinal calculations.
6. Latitudinal discrepancy calculations for the five planets.
7. First and last visibility moments for the five planets.
8. How certain particular details of Venus and Mars ascending and descending correspond to consensual hypotheses.
9. The method of estimating the distance to the Sun for individual cases of heliacal ascensions and descents.
10. Tables of heliacal ascensions and descents for the five planets.
11. Epilogue.

Therefore, the Almagest consists of 13 volumes, which occupy 430 pages of a broadsheet modern edition ([704]).

This book is also concluded in the most remarkable manner. The epilogue is as follows:

"After we have made it all come to pass, o Sire, and considered nearly everything that I believe necessary to be considered in such an oeuvre, inasmuch as the time that has passed appears to have helped with perfecting the precision of our discoveries – by no means having an idle boast as an ulterior motive,

but rather in order to be of use to science; may our present work have an apropos and a fitting ending" ([704], page 428).

As we can see, Ptolemy's work is dedicated to a certain "Sire", or Czar. Historians appear to be greatly surprised by this fact. Modern commentary is as follows: "This name [Sire = Czar – Auth.] was rather popular in Hellenistic Egypt in the epoch in question. We have no other data about this person – we don't even know whether he was associated with astronomy in any way at all" ([704], page 431). However, the very fact that the Almagest was associated with the name of a certain Czar can be proven by the following circumstance. Apparently, "Ptolemy was also ascribed royal ancestry in late antiquity and in the Middle Ages" ([704], page 431). Also, the very name Ptolemy (or Ptolomy) is presumed to have been the dynasty name of the Egyptian kings who reigned after Alexander the Great ([797], page 1076).

At any rate, according to Scaligerian chronology, the Ptolemaic dynasty left the stage around 30 B.C. ([797], page 1076) – more than a hundred years earlier than Ptolemy the astronomer, in other words. Thus, the only thing that precludes us from identifying the epoch of the Ptolemaic rulers as the epoch of Ptolemy the astronomer is Scaligerian chronology. Apparently, in the Middle Ages, when Scaligerian chronology had not yet existed, the Almagest was ascribed to the Ptolemaic kings and none other – naming them as the organisers of this grandiose endeavour or the customers who had ordered this astronomical tractate. This is why the Almagest was canonised, becoming absolutely authoritative for a long time to follow. It is easy enough to understand why the book begins and ends with a dedication to a certain Czar, or Sire. It was the royal textbook on astronomy, in a way. We shall find out just when it was written in the present book.

The first volume of the Almagest voices a number of general principles, in particular the following:

1. The sky is really a celestial sphere and rotates as such.

2. The Earth is a sphere located at the centre of the Universe (heavens).

3. The Earth can be considered a point in space as compared to the distance to the sphere of immobile stars.

4. The Earth is immobile ("doesn't travel from place to place").

Many of these claims were educed from the Aristotelian philosophy according to Ptolemy himself. Furthermore, Volumes 1 and 2 are collections of elements of spherical astronomy – the spherical triangle theorems, the method of measuring the arcs (angles) by known chords etc. Volume 3 relates the theory of visible annual motion of the Sun, discusses the dates of equinoxes, the length of a year etc. Volume 4 considers the length of a synodal month, which is the cycle of lunar phase repetition. It consists of circa 29 days, 12 hours, 44 minutes and 2.8 seconds. The same book relates the theory of lunar motion. Volume 5 discusses the construction of certain observation instruments and continues the research of the theory of lunar motion. Volume 6 describes the theory of solar and lunar eclipses.

The famous star catalogue that contains around 1020 stars is part of the seventh and the eighth volumes of the Almagest, which also discuss the properties and characteristics of immobile stars, the motions of the stellar sphere etc.

The last five volumes of the Almagest contain a theory of planetary motion. Ptolemy mentions five planets, namely, Saturn, Jupiter, Mars, Venus and Mercury.

2. A BRIEF HISTORY OF THE ALMAGEST

As we have already pointed out, Scaligerian chronology believes the Almagest to have been created in the reign of Emperor Antoninus Pius, in 138-161 A.D. Furthermore, it is presumed that the last observation included in the Almagest dates from 2 February 141 A.D. ([1358], page 1). The period of Ptolemy's observations that the Almagest is based upon falls over 127-141 A.D.

The Greek name of the Almagest translates as "Systematic Tractate on Mathematics", emphasising the fact that the Almagest represents the epoch's sum total of Greek mathematical astronomy. It isn't known whether other astronomical textbooks comparable to the Almagest existed in the epoch of Ptolemy. Modern scientists attempt to explain the unprecedented success of the Almagest among the astronomers and

scientists in general by a chance loss of the majority of all the other astronomical works of the epoch ([1358]). The Almagest was the main textbook on astronomy in the Middle Ages. If we are to believe the Scaligerian chronology, it served in this quality for fifteen hundred years, no less, making a tremendous impact on mediaeval astronomy in Islamic and Christian lands up until the XVII century A.D. The authority of this book in the mediaeval scientific community compares to nothing but Euclid's "Elements".

As it is pointed out by Toomer, for instance ([1358], page 2), it is exceptionally hard to trace the history of the Almagest and its influence in the "antiquity" (between the II century A.D. and the Middle Ages). One usually judges the role of the Almagest as the standard textbook for "advanced students" in the period of the so-called decline of the "antiquity" by the comments of Pappus and Theon of Alexandria ([1358], page 2). The Scaligerian version of history tells us of a "lugubrious and taciturn epoch" that is presumed to have followed – we shall discuss it in detail in Chapter 11. For the meantime, let us just point out the following characteristic of this fictitious Scaligerian "stagnation age" as given by a modern specialist in the history of astronomy: "After the astonishing efflorescence of the ancient culture on the European continent came a lengthy period of stagnation and even regress in certain aspects – a 1000-year period commonly referred to as the Middle Ages … Not a single astronomical discovery of any significance was made in this millennium" ([395], page 73).

Furthermore, Scaligerian history is of the opinion that in the VIII-IX century the Almagest "emerged from obscurity" due to a growing popularity of Greek science in the Islamic world and was translated into Syrian; this was followed by several Arabic translations. At least five such translation versions are known to have existed by the middle of the XII century A.D. See more about this in Chapter 11. Today it is believed that Ptolemy's work, originally written in Greek, was still copied and even studied in the East, Byzantium in particular, but not the West. "In the Western Europe, all knowledge of this work remained lost up until the early Middle Ages. Although several translations were made from Greek to Latin in the Middle Ages, the primary source for the rediscovery of the Almagest in the West was a translation from the Arabic made by Gerhard of Cremona in Toledo and finished by 1175 A.D. Greek manuscripts [of the Almagest – Auth.] started to reach the West in the XV century; however, it was Gerard's text that remained the basis of books on astronomy for ages and generations to come, up until the compilation of a concise version of the Almagest by Purbach and Regiomontanus … This was the first printed version of the Almagest (Venice, 1515). The sixteenth century witnessed a wide propagation of the Greek text (published by Hervagius in Basel in 1538) and the waning of the Ptolemaic astronomical system's influence, not so much caused by the work of Copernicus (which has been clearly influenced by the Almagest, be it the form or the conceptions voiced therein) as by those of Tycho Brahe and Kepler" ([1358], pages 2-3).

3. THE PRINCIPAL STAR CATALOGUES OF THE MIDDLE AGES

And so, the Almagest (its star catalogue in particular) ranks as the oldest more or less informative and detailed astronomical work that has reached our day and age. The approximate Scaligerian dating of the Almagest is the II century A.D. However, it is assumed that Ptolemy used the star catalogue of Hipparchus, his predecessor who had lived in the II century B.C. The catalogue in question has not survived in its original form. Likewise other mediaeval catalogues, the Almagest catalogue contains circa 1000 stars, whose positions are indicated as their latitudes and longitudes in ecliptic coordinates. It is presumed that no other star catalogues but the one contained in the Almagest were known before the X century A.D.

Finally, according to Scaligerian chronology, the first mediaeval star catalogue was compiled in the X century A.D. in Baghdad by al-Sufi, an Arabic astronomer. His full name is Abd al-Rahman ben Omar ben Mohammed ben Sala Abu al-Husain al-Sufi (903-986 A.D., qv in [544], Volume 4, page 237). The catalogue of al-Sufi has survived; a closer study reveals it to be identical to the same old Almagest catalogue. However, if the surviving copies and editions of the Almagest contain a star catalogue rendered to circa 100 A.D. by precession as a rule (although there are exceptions), the catalogue of "al-Sufi" is the very same

catalogue rendered by precession to the X century A.D. This fact is known quite well to astronomers – see [1119], page 161, for instance. Let us also point out that rendering a catalogue to a random desired historical epoch was an easy enough task. A certain constant would be added to the longitudes of stars – the same value for each and every star. This is a very simple arithmetical operation; actually, the Almagest describes it in great detail.

The next surviving catalogue in Scaliger-Petavius chronology was compiled by Ulugbek in Samarqand (1394-1449 A.D.). None of the three is very precise, since they all indicate star coordinates using a scale with a step of 10 arc minutes. Next, we have the famed catalogue of Tycho Brahe (1546-1601), which is already substantially more precise. Brahe's catalogue is believed to be the greatest advance of mediaeval instruments and observation technology in general. Post-Tychonian catalogues are abundant; however, they are of no interest to us presently.

4. THE REASON WHY THE DATING OF THE OLD STAR CATALOGUES IS AN IMPORTANT ISSUE

Every new star catalogue is the result of a great body of work conducted by an observing astronomer; most likely, a whole group of professional observers who needed all the professionalism, concentration and meticulousness they could muster as well as the ability to use state-of-the-art measurement instruments of their epoch to the maximum. Apart from that, a catalogue required a corresponding astronomical theory, or cosmology. Thus, each and every ancient catalogue was the epitome of its epoch's astronomical thought. By analysing a catalogue we can find out a lot about the epoch's quality of measurements, the level of astronomical knowledge etc.

However, in order to comprehend the results of a given catalogue's analysis, one must know the date of its compilation. Any change of date automatically changes our estimates, our concept of the catalogue etc. And it isn't always an easy task to calculate the date of a given catalogue's creation – this can be observed best in case of the Almagest. Initially, in the XVIII century, the veracity of the Scaligerian version, which attributed Ptolemy to the alleged II century A.D., was considered indisputable. However, in the XIX century a more meticulous analysis of the stellar longitudes contained in the Almagest revealed that precession-wise these longitudes correspond to the epoch of the II century B.C. – the epoch of Hipparchus, in other words. This is how A. Berry relates the situation: "The seventh and the eighth volumes [of the Almagest – Auth.] contain a star catalogue and a description of the precession. The catalogue, which includes 1028 stars (three of them double) appears to be virtually identical to that of Hipparchus. It doesn't contain a single star that could be seen by Ptolemy in Alexandria and could not be seen by Hipparchus on the Rhodes. Moreover, Ptolemy claims to have defined the value of precession as 36" (and erroneously so) after a comparison of his observations to the data of Hipparchus and other astronomers. Hipparchus considers this value as the least possible result, whereas for Ptolemy it is the final estimate. The positions of stars in Ptolemy's catalogue correspond the most to their true positions in the time of Hipparchus, taking into account the alleged annual precession of 36", and less so – to their actual positions in Ptolemy's epoch. It is therefore very likely that the catalogue in question has got nothing in common with Ptolemy's original observations, being de facto the very same catalogue as that of Hipparchus, with compensated precession only slightly altered by the observations of Ptolemy and other astronomers" ([65], pages 68-69).

The issue of dating the catalogue becomes crucial in this case. Ever since the XVIII century the astronomers and the specialists in history of astronomy have been analysing the Almagest catalogue and the Almagest in general, trying to "sort out" the data it contains, distinguish between the observations of Hipparchus and Ptolemy etc. A great deal of literature has been written about the dating of the observations that the Almagest catalogue is based on. We are by no means attempting to analyse it in depth here and refer the interested reader to [614], for instance, where one can find a guide to the respective publications.

We have another question to ask – is it possible to create a mathematical method that permits dating the ancient star catalogue "from within" – in other words, by using nothing but the numeric information contained in the star coordinates that the compiler of the

catalogue included into his oeuvre? Our answer is in the positive. We have developed a method to serve this end, tested it on several veraciously dated catalogues, and then applied it to the Almagest. The reader shall find out about our results in the present book.

Let us now cite some brief biographical data concerning the astronomers whose activities are immediately associated with the problem as described above. These data are published in Scaligerian textbooks. One must treat them critically, seeing as how the Scaligerian version of history is based on an erroneous chronology (see CHRON1 and CHRON2). We shall consider other facts that confirm it in the present book.

5. HIPPARCHUS

Scaligerian history is of the opinion that astronomy became a natural science owing to the works of Hipparchus, an astronomer from the "ancient" Greece who lived around 185-125 B.C. He is also believed to have been the first to discover the equinoctial precession, which shifts the equinox points across the ecliptic in the reverse direction from which the longitudes are counted in over the course of time. Ecliptic longitudes of all stars grow as a result. Specialists in the history of astronomy tell us the following: "Very little is known about the life of Hipparchus. He was born in Nicaea (nowadays the city of Iznik in Turkey), lived in Alexandria for a while and worked on the Isle of Rhodes, where his astronomical observatory was erected ([395], page 43).

It is believed that the explosion of a nova was the impetus which had made Hipparchus compile a catalogue of stars in the first place. Pliny the Elder (23-79 A.D.) is usually quoted in this respect – he reports that Hipparchus "discovered a new star as well as yet another star that came into being around that time". According to other sources ([395], page 51), Hipparchus noticed the explosion of a nova in 134 B.C. "This led Hipparchus to the idea that certain changes are likely to take place in the stellar world – they are too slow to be discovered within the lifetime of several generations. He decided to compile a 850-item star catalogue in order to provide his distant descendants with such an opportunity" ([395], page 51).

Ptolemy's Almagest tells us about the catalogue of Hipparchus. The catalogue itself has not survived. However, it is believed that the ecliptic longitude and latitude of each star was indicated there, as well as the magnitude. It is believed that Hipparchus localised the stars using the same terms as the Almagest: "the star on the right shoulder of Perseus", "the star over the head of Aquarius" etc ([395], page 52).

One invariably ponders the extreme vagueness of this star localization method. Not only does it imply a canonical system of drawing the constellations and indicating the stars they include – another stipulation is that there are enough identical copies of a single star chart in existence. This is the only way to make the verbal descriptions of stars such as the above work and help a researcher with the actual identification of stars. However, in this case the epoch of the catalogue's propagation must postdate the invention of the printing press and the engraving technique, since no multiple identical copies of a single work could be manufactured earlier.

Nearly the entire body of information that we have on the "ancient" Greeks' star science comes from the two surviving works – Ptolemy's "Almagest" and a work of Hipparchus entitled "A Commentary to Aratus and Eudoxus", written around 135 B.C. ([614], page 211). The issue of stellar mobility – in other words, whether or not individual stars move individually in relation to the sphere of immobile stars, was already discussed by Ptolemy, whose verdict was negative (in particular, Ptolemy begins the VII volume of the Almagest with an analysis of certain star configurations cited by Hipparchus, a long time before Ptolemy's own epoch, claiming the configurations in question to be valid for his epoch as well ([704], page 210; also [614], page 212).

"Judging by this example and several others, Ptolemy claims to have demonstrated the constancy of relative stellar positions" ([614], page 213). Therefore, according to Scaligerian history, the proper star motion issue first emerged in the II century A.D.

6. PTOLEMY

According to A. Berry, "The last glorious name we encounter in the history of Greek astronomy is that of Claudius Ptolemy. We know nothing about his life,

apart from the fact that he lived in Alexandria around 120 A.D. His fame is largely based on the enormous astronomical tractate known as the Almagest – it is our primary source of information on Greek astronomy, which can by all means be considered the definitive encyclopaedia of mediaeval astronomy.

Several lesser astronomical tractates are ascribed to Ptolemy as well – some of them are unlikely to be authentic, though. Also, Ptolemy was the author of a valuable work on geography, and, possibly, a tractate on optics as well. Among other things, the optics discipline includes the study of light refraction in the atmosphere of the Earth; it is explained in the book that the light of a star … as it enters our atmosphere … and penetrates its lower and denser layers, must eventually become curved or refracted. As a result, the star will appear closer to the zenith as seen by the observer … than it is in reality" ([65], pages 64-65).

It is however unclear whether or not the author of "Optics" could calculate refraction as a stellar latitude function. On the other hand, it is known that "Walther was the first to successfully attempt an introduction of atmosphere refraction compensation … which Ptolemy could barely conceive of" ([65], page 87). However, the character in question lived in the XV century A.D. – Bernhard Walther, 1430-1504 ([65], page 85).

So how does one date Ptolemy's "Optics"? The fact that refraction compensation remained a complex task even in the times of Tycho Brahe, or the second half of the XVI century A.D., will be related separately, in the Tycho Brahe section. One can't help suspecting that the "ancient" Optics of Ptolemy were written in this very epoch of the XVI-XVII century.

As for the name of the Almagest, this is what we learn from A. Berry: "The name of the main manuscript translates as 'The Great Work', although the author himself refers to his book as 'The Mathematical Work'. The Arabic translators, whether out of respect or accidentally, translated 'The Great Work' as 'The Greatest Work', which is why the Arabs knew Ptolemy's book as 'Al Magisti', later known as 'Almagestum' in Latin, and, finally, into 'Almagest'" ([65], page 64).

7. COPERNICUS

We shall select just a few necessary facts from the entire body of available materials associated with Copernicus. Nicolaus Copernicus (1473-1543) is one of the greatest astronomers of the Middle Ages and the author of the heliocentric theory. His ancient portrait can be seen in fig. 0.7, and another one in fig. 0.8.

Incidentally, "his name was transcribed in a variety of ways – by Copernicus himself as well as his con-

Fig. 0.7. Ancient portrait of Copernicus (1478-1443). Taken from [1160], page 310.

Fig. 0.8. Ancient drawing of Copernicus on the "Cosmosphere" of Vassily Kiprianov. Taken from [90], page 212.

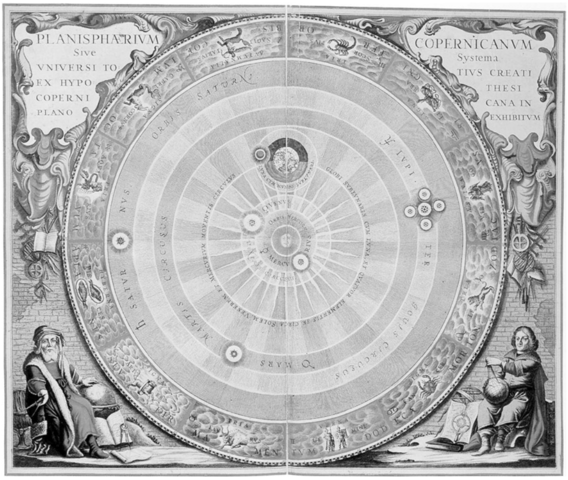


Fig. 0.9. The heliocentric system of the world according to Copernicus, as drawn in the atlas of Andreas Cellarius (Amsterdam, 1661). Taken from [1160], page 9.

Fig. 0.10. Fragment. A drawing of Copernicus from a 1661 atlas. Taken from [1160], page 9.

temporaries. He would occasionally write his name as 'Coppernic', reserving the Latin form of the name, 'Coppernicus', for his scientific works. Much less frequently he used the form 'Copernicus'" ([65], page 90). By the way, could the name 'Copernic' be a derivative of the Slavic word for "competitor", which is "*sopernik*"? In the epoch that preceded the establishment of rigidified grammar rules the letter "C" could stand for both "S" and "K".

The name "Sopernik" is in perfect concurrence with the scientific side of the matter – namely, the prominent scientist can be regarded as a competitor of his colleague Ptolemy and the author of a new conception and theory. The very concept of competition usually implies a certain chronological propinquity, if not actual contemporaneity, of the competitors.

A. Berry reports: "The crucial idea associated with the name of Copernicus, owing to which 'De Revolutionibus' is one of the seminal works in astronomical literature par none but the Almagest and Newton's 'Principia', is that, according to Copernicus, the visible motions of the celestial bodies are, for the greater part, different from their true motions, reflecting the motions of the observer carried away by the Earth" ([65], page 95).

Copernicus places the Sun at the centre of the Solar System, thus creating a heliocentric system of the Universe, qv in fig. 0.9. In the lower right corner we see a portrait of Copernicus (fig. 0.10).

Copernicus reports having encountered a passage in one of Cicero's works, which had reflected the opinion of Hecataeus that the Earth revolves around its axis on a daily basis. These ideas were inherited from the Pythagoreans. Philolaus claimed that the Earth moved around a central fire. It is perfectly clear that his stance is already heliocentric in nature. Therefore, the "ancient" Pythagoreans and Philolaus must have been contemporaries of Copernicus, or, alternatively, his immediate predecessors.

The idea that the Earth might not be the only centre of motion and that Venus and Mercury could also revolve around the Sun is believed to be an "ancient" Egyptian theory, which was also supported by Marcian Capella in the V century A.D. "Nicolaus Cusanus, a more modern authority (1401-1464) similarly inclined to believe in telluric motion, either wasn't noticed by Copernicus or deemed important enough … It is noteworthy that Copernicus remains taciturn about Aristarchus of Samos, whose ideas of telluric motion were defined perfectly well [see Chapter 11 for more details – Auth.]. It is possible that the reluctance of Copernicus to refer to such an authority as Aristarchus can be explained by the fact that the later

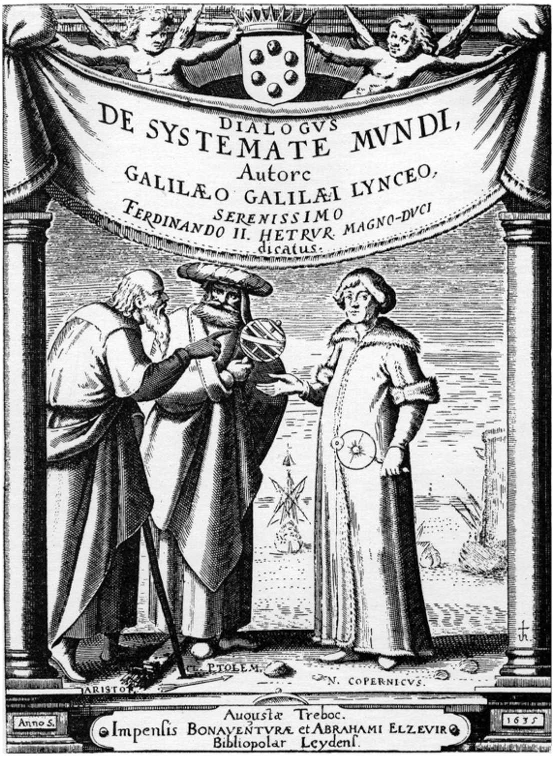


Fig. 0.11. Ancient engraving dating from 1635, found on the title page of ***De Systemate Mundi*** by Galileo Galilei. We see the "ancient" Aristotle and Ptolemy, likewise the mediaeval Copernicus, who had lived in the XVI century, drawn as contemporaries. Ptolemy is wearing a turban on his head. This is how the artist of the early XVII century saw things; consensual Scaligerian chronology should naturally deem this quite odd. A publication of Leiden, Bon. and Abr. Elsevier, 1635. Titular etching. Taken from [35], page 58, sheet XXXII.

was accused of heresy for his scientific views" ([65], pages 95-96).

According to A. Berry, "the plan of 'De Revolutionibus' is similar to that of the Almagest in general" ([65], page 97). O. Neugebauer is perfectly correct to remark as follows: "There is no better way to convince oneself that the astronomical science of the Middle Ages concurs to that of the antiquity than to perform a comparative study of the Almagest … and 'De Revolutionibus' by Copernicus. The two works are parallel - chapter by chapter, theorem by theorem and table by table" ([571], page 197).

The book of Copernicus is concluded by a star catalogue with 1024 stars in it. Specialists in the history of astronomy tell us that the catalogue "is basically identical to the catalogue of Ptolemy, the main difference being that the former counts the latitudes off the Gamma of Aries and not the vernal equinox point" ([395], page 109). Therefore, the initial reference point did not necessarily coincide with the vernal equinox in the XVI century, whatever the reason. The practice of choosing a different point as the beginning of the coordinate system may also have existed before the XVI century – in the epoch of Ptolemy, for instance. Berry also informs us of the following: "Whenever there were discrepancies between the Greek and Latin version of the Almagest, caused by the inattentiveness of the scribes or the printers, Ptolemy would accept either version without trying to verify both by new observations" ([65], page 103).

Our book pays a great deal of attention to the precision of the observations carried out by different astronomers. It would therefore be expedient to cite some data concerning the degree of precision that Copernicus had aspired to achieve. As A. Berry points out, "We have become so accustomed to associate the renaissance of astronomy … with the growing meticulousness of observation fact collection, believing Copernicus to be the primary figure of the Renaissance, that it would make sense to emphasise the fact that he was by no means a great observer. His instruments were of his own construction for the most part, and greatly inferior to the instruments of Nassir-Eddin and Ulugbek [the astronomers of the Muslim period who lived in 1201-1274 A.D. and 1394-1449 A.D., respectively – Auth.]. Moreover, they were even worse than the instruments that he could have ordered from the craftsmen of Nuremberg, had it been his intention; the observations of Copernicus were few (27 are mentioned in his book, and we know of a dozen or two more from other sources), and he was apparently unconcerned with attaining a particular degree of precision. The positions of stars that he had measured, which served him as the primary source of reference and were therefore of the greatest importance, allowed for discrepancies of 40' – greater than the visible diameter of the Sun or the Moon. Hipparchus would doubtlessly consider a discrepancy of this sort a grave error" ([65], page 93).

In fig. 0.11 we see an old engraving from the title

Fig. 0.12. The title page from the ***Celestial Atlas*** by Doppelmaier. The "ancient" Ptolemy and the mediaeval scientists of the XVI-XVII century (Copernicus, Kepler and Brahe) are drawn as contemporaries, or at least as scientists of the same epoch, conversing between themselves. Taken from [926], page 73.

page of "The Two Primary World Systems", a book by Galileo Galilei that came out in 1635 ([35], page 58, sheet XXXII). The early XVII century artist portrays three scientists here – the "ancient" Ptolemy and Aristotle next to the mediaeval Copernicus. They are depicted as contemporaries involved in a discussion of scientific problems. Today we are told that all such mediaeval artwork (which is rather plentiful, as a matter of fact) happens to be of a metaphorical nature. Modern historians interpret the conversation between Copernicus and the "ancient" scientists as a symbol used by the mediaeval artist in order to emphasise the spiritual proximity between the great scientists of the past and present. This is why the three are portrayed side by side, conversing at ease (fig. 0.12). This may indeed be the case. And yet everything we have learnt about Scaligerian chronology (see CHRON1 and CHRON2) implies the potential viability of a different version – namely, that we are to take mediaeval artwork of this sort literally and to see precisely what they show us. It is very likely that the consensual metaphorical interpretation of such artwork, which fuses the "antiquity" and the Middle Ages together, is a mere consequence of Scaligerian chronology, which arbitrarily ascribes certain mediaeval contemporaries to different epochs, severing all possible connections between them. Ptolemy, for example, has been cast into deep antiquity, whereas Copernicus more or less retained his own epoch – the XVI century.

As a matter of fact, Ptolemy's headdress looks just like a turban (see fig. 0.11). Could it be the result of his being an Ottoman scientist? Ptolemy also wears the turban-like headdress in yet another ancient portrait – see figs. 0.13 and 0.14.

In fig. 0.15 we see an old piece of artwork dating from 1666. It is evasively labelled "allegorical" – historians have no qualms about writing such things as

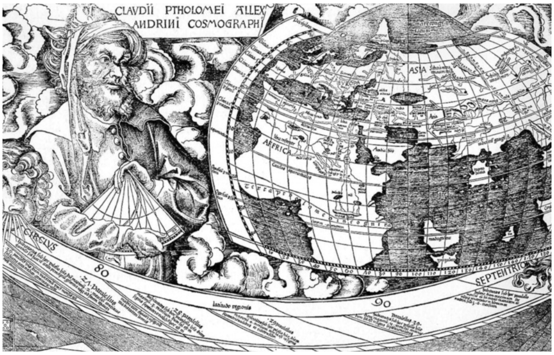


Fig. 0.13. An ancient drawing of Copernicus next to a map of the Old World. We see a headdress semblant to a turban on Ptolemy's head. A drawing from the 1507 world map by Martin Waldseemüller (Martin Waldseemüller's Weltkarte von 1507, Abb. S. 114/115). Taken from [1009], page 12.

Fig. 0.14. A close-in of a fragment of the previous drawing. Taken from [1009], page 12.

Fig. 0.15. An ancient drawing of Claudius Ptolemy (standing on the left), and three famous mediaeval cartographers: Gerardus Mercator (sitting in the centre), Jodocus Hondius and Willem Blaeu (sitting on the right). Title page from the ***Concise Atlas*** by Johannes Jansson. Amsterdam, 1666. An engraving by J. Weisheer made after the drawing of S. Webbers. Chisel. Once again, historians suggest these characters (Ptolemy and the three cartographers of the XVI-XVII century) to be separated from each other by some 1300-1400 years. We see two muses next to Ptolemy. Taken from [90], page 6.

Fig. 0.16. A close-in of a fragment of the above picture. We see a pair of mediaeval spectacles on the face of the "ancient" Ptolemy. It is most likely that in the XVII century people still remembered Ptolemy as a scientist from the epoch of the XIV-XVI century. Taken from [90], page 6.

Fig. 0.16a. Monk with spectacles ([497:1], page 35).

Fig. 0.17. An ancient drawing of Ptolemy observing the stars. Etching on wood, 1517. We see Ptolemy wear a royal crown – a mediaeval one, which is rather remarkable. We see such trefoil crowns in many mediaeval coats of arms. Taken from: Gregor Reisch, ***Margarita philosophica …*** Basel: Michael Furter, 1517. Taken from [1009], page 21.

Fig. 0.18. A close-in of the fragment with the mediaeval royal crown on the head of the "ancient" Ptolemy. Taken from [1009], page 21.

"the Allegory of Cartography and the prominent cartographers: Claudius Ptolemy, Gerhard Mercator, Judocus Hondius and Willem Blau" ([90], page 6). Ptolemy is on the left surrounded by two "muses". However, the fact that the XVII century artist had no doubts about portraying the "ancient" Ptolemy and three other cartographers of the XVI-XVII century side by side may very well mean that he was perfectly correct in his doing so. By the way, we see the "ancient" Ptolemy wearing spectacles, a typically mediaeval object (fig. 0.16). This drawing also emphasises a rather personal detail – Ptolemy appears to be adjusting the spectacles that have slid to the tip of his nose. Ptolemy may have worn glasses in reality, and this rather characteristic trait of his may have been remembered by the mediaeval artist and reproduced on the drawing. We feel obliged to remind the reader that spectacles appeared in the XIII century the earliest ([497:1], pages 34-35). "Around the middle of the XIV century spectacles were already a very common object – a fresco of 1352 depicts a bespectacled monk" ([497:1], page 35). We reproduce this drawing in fig. 16a.

In fig. 0.17 we see an old portrait of Ptolemy that dates from 1517 ([1009], page 21). Ptolemy is wearing a trefoil royal crown on his head (fig. 0.18). These crowns are virtually identical to the kingly crowns worn by the Evangelical Wise Men as portrayed on the mediaeval sarcophagus of the Three Wise Men, for instance (it is located in the famous Cologne Cathedral in Germany – see Chron6, Chapter 3). We can also see three crowns of the same trefoil design adorning the mediaeval coat of arms of Cologne (figs. 0.19 and 0.20). Mediaeval crowns of this shape are

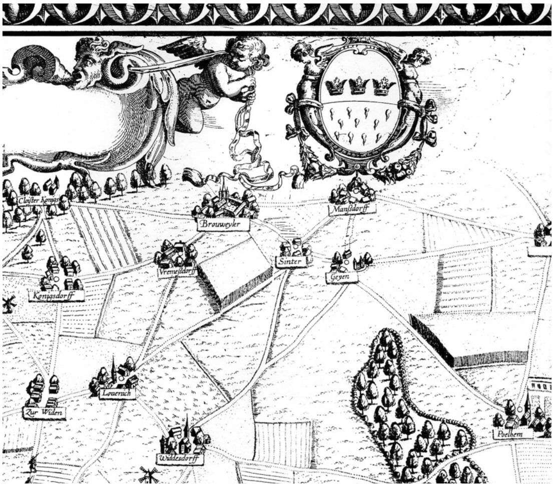


Fig. 0.19. A fragment of a mediaeval map depicting the German city of Cologne, dating from 1609. The engraving was made by Abraham Hogenberg. We see three royal crowns of the same shape as the one worn by the "ancient" Ptolemy. Taken from [1228].

Fig. 0.20. A close-in of the fragment with the coat of arms of Cologne with the crowns. Taken from [1228].

Fig. 0.21. An ancient French miniature of the Rhemish Missal dating to 1285-1297 (Missel à l'Usage de Saint-Nicaise de Reims. The royal crowns we see here are of the same shape as the one worn by Ptolemy. Taken from [537], page 207.

Fig. 0.22. A close-in of the fragment with the royal crowns. Taken from [537], page 207.

encountered in a great deal of mediaeval artwork portraying royalties and dating from the XIV-XVI century (in Sweden, for instance).

We see trefoil royal crowns that are perfectly similar to the above in mediaeval French miniatures (such as one may find in the famed Rhemish Missal created between 1285 and 1297, for example). See [537], pages 194 and 207; also figs. 0.21 and 0.22.

Therefore, we see the "ancient" Ptolemy wearing a famous mediaeval crown on his head. See more on the history of the trefoil crown of the Great = "Mongolian" Empire in CHRON7, Chapter 15:2.

8. TYCHO BRAHE

Tycho Brahe (1546-1601) was one of the most renowned astronomers of the Middle Ages, a professional scientist who played a major part in the development of fundamental astronomical conceptions. On 21 August 1560, in his second year at the University of Copenhagen, there was a solar eclipse observed as partial in Copenhagen. Tycho Brahe was astonished by the fact that this event had been predicted earlier ([395], page 123). This event impelled Tycho Brahe to develop a deep interest in astronomy.

An old portrait of Tycho Brahe can be seen in fig. 0.23. In fig. 0.24 we see an old engraving that portrays Tycho Brahe, his colleagues and his famous quadrant. In fig. 0.25 we reproduce another version of the very same engraving in order to draw the reader's attention to the rather liberal manner in which the "copyists" treated old artwork. The two versions strike one as identical at first sight; a more in-depth study reveals substantial discrepancies. They lead to no confusion in this particular case, but the very fact that mediaeval copyists did not deem it necessary to reproduce originals faithfully leads one to certain conclusions.

In 1569 Tycho Brahe was in Augsburg, the residence of the craftsmen who manufactured instruments of sufficiently high precision for the observation of celestial bodies. This is where Tycho's quadrant and sextant were made, followed by another quadrant with a radius of circa 6 metres. The full height of this instrument equalled 11 metres, and it could count angles with the precision of 10". On 11 November

Fig. 0.23. An ancient portrait of Tycho Brahe. Taken from [1160], page 310.

1572 Tycho Brahe noticed a bright star in the constellation of Cassiopeia, which hadn't been there before. He instantly started the angular distances between this new star and the main stars of Cassiopeia as well as the North Star. Somewhat later, Kepler wrote: "Even if this star wasn't really an omen of any sort, it has heralded and made a great astronomer at the very least". The Tychonian supernova was brighter than Venus, and could be seen for 17 months with the naked eye, even in the daytime.

We are told that in 1576 King Frederick II of Denmark and Norway bestowed the Isle of Hven near Copenhagen upon Tycho Brahe. He also invested a large sum of money into the construction of the Uraniborg observatory there – the name translates as "The Castle of Urania". We shall discuss the possible true location of this observatory below, in Chapter 10. It was most likely at a considerable distance from Copenhagen. The observatory was equipped with precise angular instruments. Several years later, the observatory of Stjerneborg ("Star Castle") was built. All the measurement instruments were installed underground so as to protect them from environmental

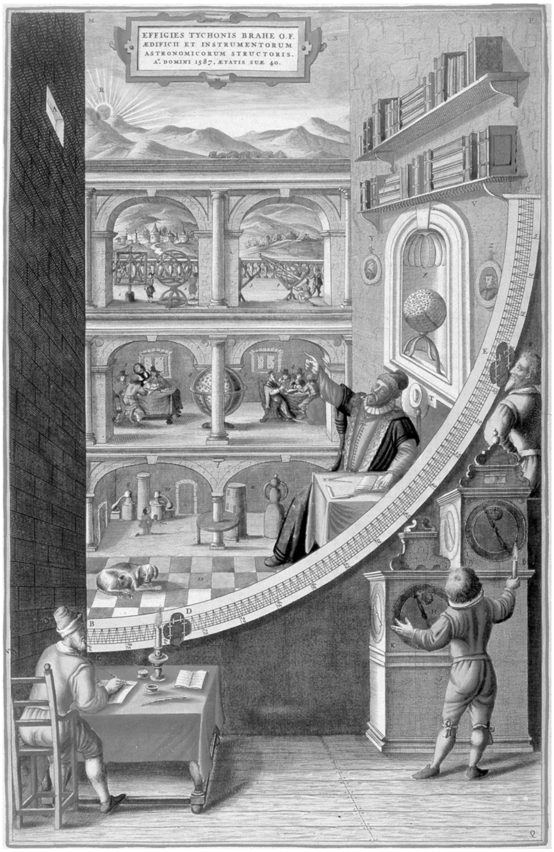


Fig. 0.24. An ancient drawing of Tycho Brahe and his famous quadrant. Taken from [1160], page 311.

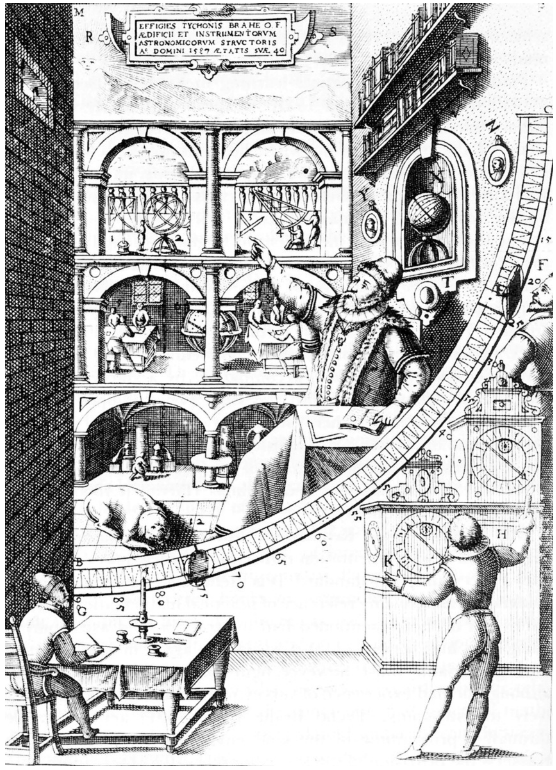


Fig. 0.25. Another version (?) of the old engraving presented in the previous figure. Tycho Brahe and his quadrant. Mark the fact that these two drawings differ from each other somewhat; nevertheless, each of them is declared to be original nowadays! Taken from [1029], page 24.

disturbances of any kind. The Isle of Hven became a unique astronomical centre of global importance, and remained one for over 20 years. This is where Tycho, accompanied by his apprentices, conducted observations of exceptional and unprecedented precision. Unique astronomical instruments were manufactured there as well ([395], page 126).

Diagrams and descriptions of Tycho Brahe's primary instruments were published in his book entitled "The Mechanics of Updated Astronomy" (published in 1598). First and foremost, Tycho used quadrants with radiuses of 42, 64 and 167 cm. The most famous of all was the 194-centimetre quadrant, whose arc of cast brass was rigidly affixed to the eastern wall of the observatory (precisely oriented at the North and the South). Special techniques of raising the precision of observations allowed for calculation precision margin of 10" or less (5" in case of the "wall quadrant"). The latter required 3 people for operation – one to watch the celestial sphere and record the height of the celestial object under study, another to write the data down in a journal, and yet another person to record the time of meridian crossing with the aid of several chronometers, no less, installed right there in the observatory (see figs. 0.24 and 0.25). In 1581 Tycho Brahe used a chronometer with an extra hand for seconds, estimating their precision margin as four seconds.

Another group of instruments comprised the sextants. Tycho Brahe oversaw and directed the manufacture of several armillary spheres. "One must mention a large globe of 149 centimetres in diameter,

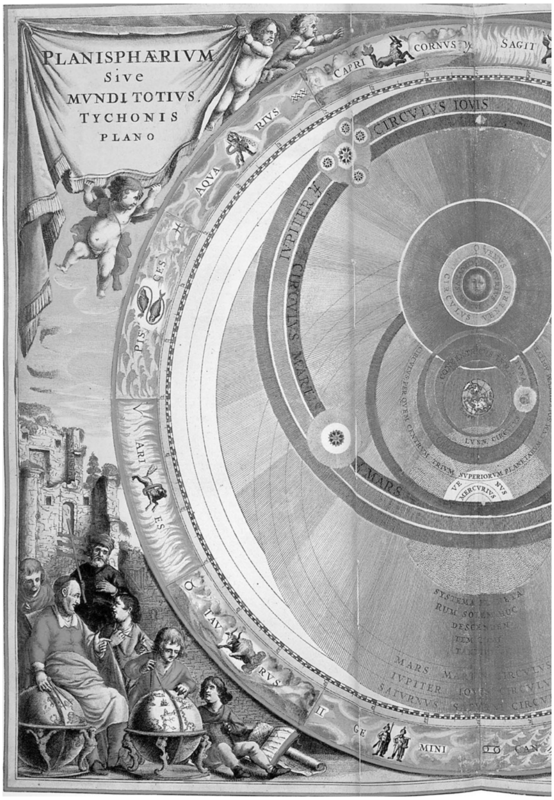


Fig. 0.26. A diagram of the Universe according to Tycho Brahe, taken from the atlas by Andreas Cellarius of Amsterdam and dating to 1661. Taken from [1058], page 20. Left half of the map.

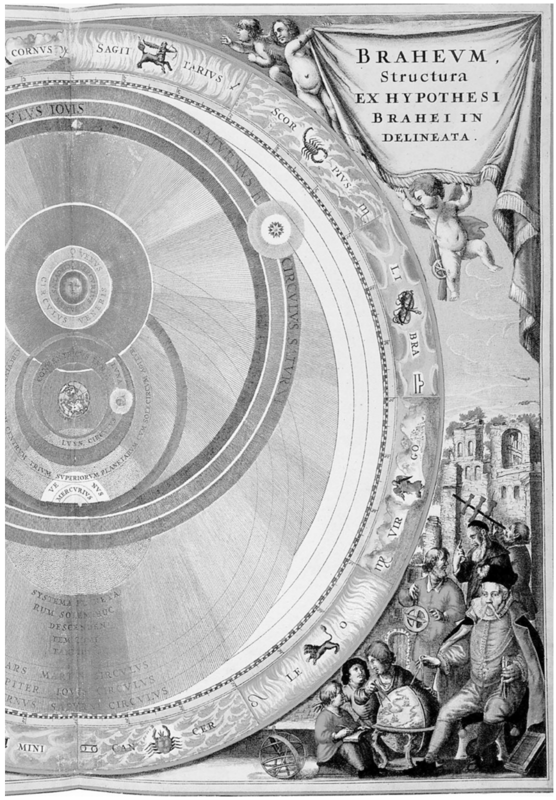


Fig. 0.27. A diagram of the Universe according to Tycho Brahe, taken from the atlas by Andreas Cellarius of Amsterdam and dating to 1661. Taken from [1058], page 20. Right half of the map.

whose surface was covered by thin sheets of brass and depicted the Zodiacal belt, the equator and the positions of 1000 stars; their coordinates were calculated over the many years of Tycho's observations. He was proud of his creation, claiming 'No globe of this size, manufactured with as much diligence and finesse, has ever been made anywhere in the world to the best of my knowledge'… Alas, this true miracle of science and art was destroyed in a blaze in the second half of the XVIII century" ([395], page 127).

According to the evidence of Tycho's contemporaries, his work stamina was just as amazing as the meticulousness of his scientific research. He checked and re-checked the results of numerous observations personally, striving to bring them to perfection. In figs. 0.26 and 0.27 we reproduce the diagram of Tychonian cosmology taken from the atlas of Andreas Cellarius published in 1661 in Amsterdam ([1058], page 20). We see Tycho Brahe in the lower right corner (fig. 0.28).

This phase of success ended rather abruptly. Christian IV, the new King of Denmark, expropriated Tycho Brahe's estates, which had been providing him with the funds necessary for maintaining the observatory in a constant state of functionality. In 1597 Tycho left Denmark and eventually settled down near Prague, founding a new observatory there. Johannes Kepler began his career as Brahe's apprentice (see fig. 0.29). On 13 October 1601, Tycho Brahe fell ill and died on 24 October 1601 at the age of 55. The famous Uraniborg observatory was destroyed completely – there isn't a single trace of it in existence today.

Fig. 0.28. A fragment of the previous illustration depicting Tycho Brahe.

Alternatively, it could have been located in an altogether different place (see Chapter 10).

"In 1671 Picard went to Denmark in order to find out about the fate of Tycho Brahe's observatory on the Isle of Hven. Picard found a pit filled with rubbish where the magnificent castle had formerly stood, and was forced to conduct excavations in order to locate the foundation" ([65], page 181). Thus, a great deal of information about the life and work of Tycho Brahe has been lost, notwithstanding the fact that he didn't really live all that long ago. "The was hardly anyone to use the large instruments of Tycho after his death – most of them perished in the epoch of the Bohemian civil wars. Kepler managed to obtain a copy of Brahe's observation records, but they were raw and unedited. Publications were few and far between" ([65], page 127).

It is believed that around 1597-1598 Tycho Brahe "distributed some handwritten copies of his 1000-star catalogue. Only 777 stars had been observed and measured properly, and so Tycho made haste to register all the rest of the stars, wishing to add to the traditional number" ([65], page 126).

Let us linger on the precision of Tycho Brahe's observations for a while. In the epoch of Copernicus, a single measurement step equalled 10' – just like it did in the Ptolemaic epoch, since 10' also constitute the value of the Almagest precision margin. It is believed that Tycho Brahe managed to make the measurements of the equatorial star coordinates some 50 times more precise – namely, the average precision margin of the coordinates of eight referential stars measured by the wall quadrant equals 34.6" (33.2" in case of the astronomical sextant). This level of precision is believed to be close to the theoretical possible precision limit for any astronomical observations conducted before the invention of the telescope ([395], pages 128-129).

However, such great precision of equatorial stellar coordinate measurement was compromised by the transition to the ecliptic coordinate system, which requires the knowledge of the angle between the ecliptic and the equator. Tycho Brahe's calculations of this angle yielded the figure of $\varepsilon = 23° 31' 5''$, which exceeds the true value by 2'. This can be explained by the fact that Tycho corrected his star declination measurements taking refraction and solar parallax into account. "Following Aristarchus of Samos, he accepted the theory [? – Auth.] that the distance between the Earth and the Sun was 19 times greater than that between the Earth and the Moon, which makes solar parallax equal 1/19th of the lunar parallax, or 3'. Tycho wrote the following in this respect: 'the ancients appear to have carried out the measurement in question with enough attention to detail for us to adopt the end value as sufficiently reliable'. He made a mistake, though …" ([395], page 129).

Thus, the precision margin of the ecliptic stellar coordinates in Tycho Brahe's equals 2' or 3'. We shall confirm this result independently, using our catalogue dating method; in particular, it allows us to estimate the real precision of star observations as conducted by the ancients.

As we learn from A. Berry, "obviously enough, the true precision of Tychonian observations fluctuated significantly, depending on the character of the ob-

servation, the diligence of the observer, and the period of Tycho's life when the observation was carried out. The discrepancy between the coordinates of the nine stars that form the basis of his star catalogue and their equivalents yielded by the best modern observations is smaller than 1' in most cases (equalling 2' in case of just a single star). This error was caused by refraction primarily – Tycho's familiarity with the latter phenomenon could not have been anything but perfunctory. The positions of other stars must have been measured with less precision. Still, we shall hardly be that much off the mark if we assume that in most cases the precision margin of Tycho's observations did not exceed 1' or 2'.

According to one of the most frequently quoted passages of Kepler's oeuvre, errata of 8' were completely out of the question for Tycho's planetary observations" ([65], page 128).

A. Pannekuk reports: "Tycho estimated the direct ascensions and declinations of his referential stars, totalling 21, with the greatest precision; the mean error value is less than 40" as compared to modern data" ([643], page 229).

A. Berry suggests the following reasons why Tycho Brahe was the first to attain a sufficiently high level of observation precision: "To a certain extent, such precision can be explained by the size and the excellent construction of his instruments – this is something that the Arabs and other observers had always sought to achieve. It goes without saying that Tycho used brilliant instruments – however, they became a great deal more efficient in his hands for two reasons, the first being his innovative use of minor mechanical accessories, such as special dioptres or particular kinds of horizontal gradation, and the second, the fact that the motion range of his instruments was very limited, which would substantially enhance their stability as compared to the devices that can be directed at any part of the celestial sphere.

Another great improvement was his systematic compensation of the inevitable mechanical imperfections that affect even the best of the instruments as well as the more constant errata. For example, it had been long known that the refraction of the light in the atmosphere makes the stars seem located somewhat higher than they really are. Tycho endeavoured to carry out a series of observations in order to estimate the value of this shift for different parts of the celestial spheres. He came up with a rather rudimentary refraction table as a result, and made regular refraction compensation an integral part of all his further observations" ([65], page 129).

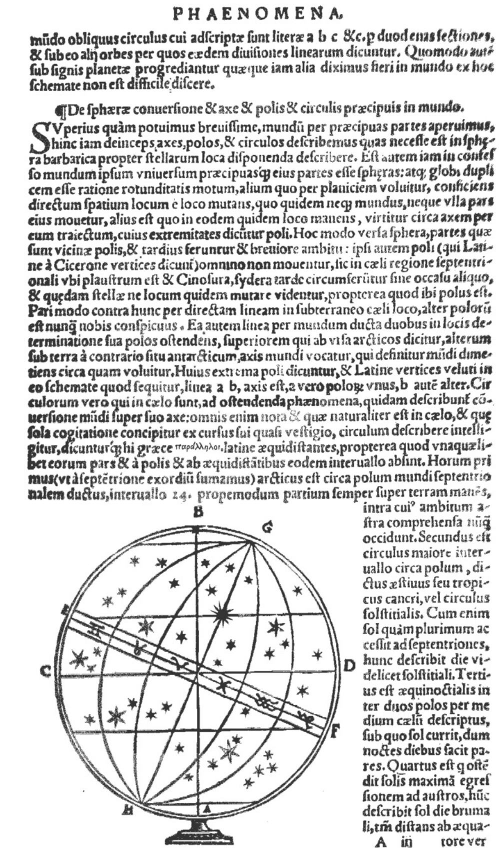
Fig. 0.29. An ancient portrait of Johannes Kepler. Taken from [926], page 69.

Apart from that, Tycho Brahe accounted for the parallax effect. "He was among the first scientists to appreciate the full importance of numerous repetitions of the same kind of observations under varying conditions so as to make all the assorted random errata introduced by individual observations neutralise each other" ([65], page 129).

All the above facts demonstrate that Tycho Brahe was a perfectionist and a very meticulous astronomer of great professionalism. This makes the following circumstance, pointed out by A. Berry, as well as many other authors, seem very odd indeed: "Unfortunately, he did not measure the distance to the Sun, accepting the veracity of the extremely rough estimate that had remained unaltered since the very epoch of Aristarchus, passing from one astronomer to another" ([65], page 130). From the consensual point of view, this "institution of astronomical heritage" must have

been about two thousand years old in the epoch of Tycho Brahe. If he did in fact consider this information "ancient", why didn't he verify it, being the brilliant professional that he was? It would be all the more natural given that "he had made corrections and new measurements to define nearly every astronomical value that was of any importance at all" ([65], page 129).

In fig. 0.30 we see a page from a 1537 edition of the Almagest.


PHAENOMENA.

mūdo obliquus circulus cui adſcriptæ ſunt literæ a b c &c. p duodenas ſectiones, & ſub eo alij orbes per quos eædem diuiſiones linearum dicuntur. Quomodo autē ſub ſignis planetæ progrediantur quæque iam alia diximus fieri in mundo ex hoc ſchemate non eſt difficile diſcere.

¶De ſphæræ conuerſione & axe & polis & circulis præcipuis in mundo.

SVperius quàm potuimus breuiſſime, mundū per præcipuas partes aperuimus, hinc iam deinceps axes, polos, & circulos deſcribemus quas neceſſe eſt in ſphęra barbarica propter ſtellarum loca diſponenda deſcribere. Eſt autem iam in confeſſo mundum ipſum vniuerſum præcipuasq; eius partes eſſe ſphęras: atq; globi duplicem eſſe ratione rotunditatis motum, alium quo per planiciem voluitur, conficiens directum ſpatium locum è loco mutans, quo quidem neq; mundus, neque vlla pars eius mouetur, alius eſt quo in eodem quidem loco manens, virtitur circa axem per eum traiectum, cuius extremitates dicūtur poli. Hoc modo verſa ſphera, partes quæ ſunt vicinæ polis, & tardius feruntur & breuiore ambitu: ipſi autem poli (qui Latine à Cicerone vertices dicunt) omnino non mouentur, ſic in cæli regione ſeptentrionali vbi plauſtrum eſt & Cinoſura, ſydera tarde circumferūtur ſine occaſu aliquo, & quędam ſtellæ ne locum quidem mutare videntur, propterea quod ibi polus eſt. Pari modo contra hunc per directam lineam in ſubterraneo cæli loco, alter polorū eſt nunq̄ nobis conſpicuus. Ea autem linea per mundum ducta duobus in locis determinatione ſua polos oſtendens, ſuperiorem qui ab viſa arcticos dicitur, alterum ſub terra à contrario ſitu antarcticum, axis mundi vocatur, qui definitur mūdi dimetiens circa quam voluitur. Huius extrema poli dicuntur, & Latine vertices veluti in eo ſchemate quod ſequitur, linea a b, axis eſt, a vero polorū vnus, b autē alter. Circulorum vero qui in cælo ſunt, ad oſtendenda phænomena, quidam deſcribunt cōuerſione mūdi ſuper ſuo axe: omnis enim nota & quæ naturaliter eſt in cælo, & quę ſola cogitatione concipitur ex curſus ſui quaſi veſtigio, circulum deſcribere intelligitur, dicunturq; hi græce παράλληλοι, latine æquidiſtantes, propterea quod vnaquælibet eorum pars & à polis & ab æquidiſtātibus eodem interuallo abſint. Horum primus (vt à ſeptētrione exordiū ſumamus) arcticus eſt circa polum mundi ſeptentrionalem ductus, interuallo 24. propemodum partium ſemper ſuper terram manēs, intra cui⁹ ambitum aſtra comprehenſa nūq̄ occidunt. Secundus eſt circulus maiore interuallo circa polum, dictus æſtiuus ſeu tropicus cancri, vel circulus ſolſtitialis. Cum enim ſol quàm plurimum acceſſit ad ſeptentriones, hunc deſcribit die videlicet ſolſtitiali. Tertius eſt æquinoctialis inter duos polos per medium cæli deſcriptus, ſub quo ſol currit, dum noctes diebus facit pares. Quartus eſt q oſtēdit ſolis maximā egreſſionem ad auſtros, hūc deſcribit ſol die brumali, tm̄ diſtans ab æquatore ver

A iii

Fig. 0.30. A page from a 1537 edition of the Almagest.

9. IMPORTANT RESEARCH OF THE ALMAGEST BY THE ASTRONOMER ROBERT NEWTON AND HIS BOOK ENTITLED "THE CRIME OF CLAUDIUS PTOLEMY"

We shall occasionally compare our results to the results of Robert Newton's fundamental scientific research of Ptolemy's Almagest ([614]). A portrait of Robert Newton can be seen in fig. 0.31.

Robert Newton (1919-1991) was a prominent American scientist. Let us cite some facts about him from the official obituary of 5 June 1991 (died 2 June 1991 in Silver Spring, MD, USA). "He was a scientist of international renown due to his research concerning the shape and the motion of the Earth … He was a specialist in the theory of ballistics, electronic physics, celestial mechanics and satellite trajectory calculation. His career started in APL's Space Department in 1957, where he was put in charge of the satellite motion research … He is to be credited with his fundamental contribution to the major improvements in navigation precision … He was head of the space exploration programme and the developer of the satellite navigation lab's analytical aspects … He was the chief architect of the Navy's Transit Satellite Navigation System, which was developed in the laboratory in the 1960's. This navigation system is still used by more than 50.000 private, commercial and military vessels and submarines … His research of satellite motion made it feasible to calculate the shape of the Earth with greater precision, which has resulted in more precise measurements … R. Newton was a member of the Ad Hoc Committee on Space Development Director Board and became the leader of APL's Space Exploration Group in 1959 … In the late 1970's he also became involved in the research of the ancient astronomical records of solar and lunar eclipses … This research gave him a reason to doubt the information contained in the main oeuvre of the famous astronomer Claudius Ptolemy and to accuse the latter of fraud in his book, "The Crime of Claudius Ptolemy" … Among other things, R. Newton was the Professor of Physics at the Tulane University and the University of Tennessee, having also worked for the Bell Telephone Laboratory … and developed the missile ballistics at the Allegany Ballistic Laboratory, Cumberland".

We believe it to be perfectly appropriate to voice our attitude towards the famous book of Robert Newton – "The Crime of Claudius Ptolemy" ([614]), since it has become rather controversial among the modern authors of works on the history of astronomy. I. A.

Klimishin, for instance, writes the following about Newton's book in [395]: "What we encounter here is an intent to prove that nearly the whole bulk of Ptolemy's observations, which constitute the foundation of the Ptolemaic theory of solar, lunar and planetary motion, happens to be a fraud" ([395], page 56). I. A. Klimishin doesn't counter Robert Newton's conclusions with any ostensible astronomical or statistical argumentation, opting to abandon the factual discussion of the issue altogether and contenting himself with the following statement: "And yet the main reason for Ptolemy's universal fame was his theory of planetary motion, which had made it feasible to calculate the positions of planets dozens of years into the future, no less!" ([395], page 56). However, the value of the Ptolemaic model can by no means shed any light on the Almagest star catalogue's compilation history or indeed reveal anything about the origins of the Almagest in general. Similar statements of disagreement with the conclusions made by Robert Newton (containing no counter-argumentation of any substance) have been voiced by a number of other specialists in the history of astronomy, such as Gingerich ([1153]).

In reality, the book of Robert Newton encapsulates his fundamental research of the Almagest with the aid of mathematical, astronomical and statistical methods. It contains a vast body of statistical material and several deep conclusions that sum up many years of Robert Newton's labour. These results elucidate the nature of difficulties associated with the interpretation of the astronomical data contained in the Almagest. It has to be emphasised that Robert Newton hadn't a iota of doubt about the veracity of the Almagest's consensual dating (which falls over the period between the II century B.C. and the II century A.D.). Robert Newton was no historian, and he had to rely on the Scaligerian version of history, using it as the chronological framework for his own research. The main corollaries of Robert Newton can be formulated as follows:

1) The astronomical environment that corresponds to the beginning of the A.D. era (as calculated with the aid of modern theory) is at odds with the "observation material" included in Ptolemy's Almagest.

2) The surviving version of the Almagest does not contain any original astronomical observation data at all – the Almagest data are the end product of somebody's conversions and calculations aimed at making the initial observation data fit another historical epoch. Moreover, a substantial part of the "observations" included in the Almagest also result from later theoretical calculations included in the Almagest ex post facto as "the observations of the ancients".

Fig. 0.31. A portrait of Robert Newton, the American scientist (1919-1991).

3) The Almagest could not have been compiled in 137 A.D., which is the epoch that the "ancient" Ptolemy's lifetime dates to in the consensual history of today.

4) Consequently, the Almagest was compiled in some other epoch and requires a new dating. Robert Newton himself has made the assumption that the Almagest was in need of "extra age", or a shift backwards in time that would place it in the epoch of Hipparchus – circa the II century B.C., that is. However, this does not alleviate any of the fundamental problems discovered by Robert Newton.

5) Robert Newton had initially agreed with the consensual hypothesis about the Almagest containing Ptolemy's own claim that all of his observations were carried out by none other but Ptolemy himself – allegedly around the beginning of the reign of Antoninus Pius, a Roman emperor. The Scaligerian dating of his reign is 138-161 A.D. Robert Newton makes the instant self-implied conclusion that Ptolemy was lying as a result. Actually, we shall deal with the issue of just how strongly the information contained in the Almagest implies that Ptolemy carried out all of his stellar observations by himself during the reign of Antoninus Pius.

In other words, Robert Newton opines that Ptolemy himself (or somebody else acting on his behalf) was a fraud, seeing as how the Almagest data are presented as the results of actual astronomical observations when they really owe their existence to conversions and theoretical calculations.

As a serious and renowned scientist faced by the necessity of voicing a number of straightforward ac-

cusations against Ptolemy or his editors, Robert Newton remained uncertain about the best form of his scientific results' publication. At the very least, this is the motivation he voiced in a private missive to A. T. Fomenko, which had concerned with the history of the creation and publication of his book ([614]) in 1977 (R. Newton and A. T. Fomenko exchanged a few letters about the problems of historical chronology in the 1980's). However, Robert Newton has finally considered his discovery of the situation with the Almagest important enough to obey his duty of a scientist and even use his accusations as the headers of some of his books' paragraphs ([614]). Let us quote some of them, since they really do speak volumes.

"5:4. The alleged observations of the equinoxes and the solstices by Ptolemy.

5:5. The fabricated solstice of 431 B.C. (the solstice of Meton).

5:6. Ptolemy's observations aimed at the estimation of the ecliptic declination angle and the latitude of Alexandria.

6:6. Four fabricated lunar eclipse triads.

6:7. Proof of fraud.

6:8. The culprit.

7:4. Fraudulent calculations and miscalculations.

10:5. The falsification of data.

11:5. Falsified data concerning Venus.

11:6. Falsified data concerning the external planets" ([614], pages 3-5).

In the very first lines of his foreword to [614], Robert Newton says the following. "This book tells the story of a certain crime against science. I am neither referring to carefully planned criminal activity of any sort, nor indeed to the kind of crime committed with the aid of such devices as hidden microphones, messages ciphered in microfilm, and so on. I am referring to a crime committed by a scientist against his learned peers and apprentices and a betrayal of professional integrity and ethics – a crime that has forever deprived humanity of certain fundamental information pertaining to the most crucial fields of astronomy and history.

I have demonstrated that the crime in question was indeed committed in four of my previously published works … When I began my work on this book, my objective had been to collect the materials scattered across several publications into a single book … However, by the point that I'd written the first third of this book, I have discovered the evidence that proves the crime in question to be rooted much deeper that I had expected initially. The present work is therefore a collection of old and new evidence to testify to the commission of the crime in question" ([614], page 10).

Robert Newton concludes his book as follows:

"This is a final summary of results. All of Ptolemy's own observations that he uses in the 'Syntax' [the Almagest – Auth.] have turned out fraudulent, inasmuch as their veracity could be tested. Many of the observations ascribed to other astronomers are also part of Ptolemy's fraud. There are theoretical errata galore in his work, and it also reveals a lack of comprehension on the part of the author … His models for the Moon and Mercury contradict the most elementary observations and must be considered a failure. The very existence of the 'Syntax' has resulted in the loss of many authentic works written by the astronomers of Greece – we have ended up with the legacy of a single solitary model, and we even lack so much as the certainty of whether this contribution to astronomical science can actually be attributed to Ptolemy at all. I am referring to the equant model, which was used for Venus and the external planets. Ptolemy greatly diminishes its value by a somewhat improper application of the model in question. It is becoming perfectly clear that no statements made by Ptolemy can be accepted at face value, unless they are confirmed by independent authors unaffected by Ptolemy's influence. All the research based on the 'Syntax' must be started from scratch once again, be it historical or astronomical.

I am yet unaware of the other people's possible opinions; still, I can make but a single final judgement: the 'Syntax' has turned out more detrimental to astronomy than any other book ever written, and the astronomical science would benefit greatly, had this book never existed.

Therefore, Ptolemy is by no means the greatest astronomer of the antiquity, but rather an even odder figure: he is the most successful con man in the history of science" ([614], pages 367-368).

A number of other scientists are also rather sceptical about the part played by Ptolemy in the history of science. In particular, A. Berry relates the follow-

ing: "There is a great deal of controversy in what concerns the astronomers' opinions of Ptolemy's merits. In the Middle Ages, his astronomical authority was considered decisive … Modern critics have discovered the fact that Ptolemy's works were largely based on those of Hipparchus (actually, Ptolemy never made any secret of it), and that the results of his own observations, if not de facto fraudulent, are largely substandard at the very least" ([65], page 72).

Therefore, Robert Newton has proven the necessity of re-dating the Almagest – astronomically as well as mathematically. This leads us to the following question – which epoch does the Almagest really pertain to? As we have mentioned earlier, Robert Newton himself suggests moving it backwards in time - to the epoch of Hipparchus. Other points of view are also viable; we shall discuss them in detail below. At any rate, Robert Newton does not discuss the problem of dating or even address it. Is it at all possible to find a historical epoch that would fit the Almagest better and effectively solve the problems discovered by Robert Newton, as well as the earlier researchers, no matter how distant from the Scaligerian dating of the Almagest? As we shall see further on, Robert Newton's suggestion to mitigate the controversy by means of shifting the Almagest backwards in time (into the epoch of Hipparchus, that is) doesn't lead us anywhere. This is why we have to ask the obvious question of whether there may be other possible shifts of the Almagest dating to consider – possibly, amounting to longer periods than 200 or 300 years. This question of ours is perfectly justified from the mathematical and astronomical point of view, and finding a correct answer is nothing short of a duty from the independent researcher's point of view.

The publications of R. Newton were followed by a work of Dennis Rowlins ([1365]), wherein he uses an independent method to prove that the stellar longitudes contained in Ptolemy's catalogue have been recalculated and altered by someone. In other words, D. Rowlins claims that the stellar longitudes that we find in Ptolemy's catalogue could not have been observed in the epoch of 137 A.D. The research results of Robert Newton and Dennis Rowlins can be found in [1119] and [1120].

Furthermore, such works as [1119], [1120] and [1182] address the issue of the southernmost Almagest catalogue stars' waning brightness. The matter is that the stars that aren't elevated sufficiently high above the horizon lose a lot of their luminosity, due to the fact that the human line of eyesight approximates the surface of the Earth. As a result, the ray travels further in the atmosphere than in case of the stars situated further away from the horizon. This is why the southern stars appear dimmer to the observer than they really are. Our analysis of the southernmost Almagest stars' luminosity has revealed that the observations of these stars were carried out somewhere far in the south. In particular, these considerations rule out the very possibility that Ptolemy performed his observations anywhere in the vicinity of the Isle of Rhodes, which happens to be the consensual localization of his observation point ([1182]). Alexandria in Egypt fits somewhat better – yet we shall find out that even Alexandria does not quite satisfy to the stipulations of the Almagest data. The luminosity estimate of the southernmost stars implies an even more austral latitude.

We must also note that the coordinates of the stars in question are measured exceptionally badly, with discrepancies of several degrees, qv below. If the Almagest is indeed a product of the late Middle Ages, this circumstance is easy enough to explain. Apparently, the austral stars were added to Ptolemy's catalogue as a result of observations carried out somewhere far in the South – possibly, India, and not Alexandria, or the deck of a ship sailing the South Atlantic. The luminosity of the stars was measured correctly, though, unlike their coordinates. This may be explained by the possible imperfections of the southern observatories, or a poor concurrence of different observatories' data. Finally, if the southernmost stars were indeed observed from some vessel, the low precision of the end result is even less of a mystery.

It was only in the time of Huygens that the clock became an integral part of many astronomical instruments: "One of the inventions made by Huygens completely revolutionized the art of precise astronomical observation. Huygens attached the pendulum to the clock that was set in motion by weights, in such a manner that the clock maintained the pendulum in motion, which, in turn, regulated the motion of the clockwork.

It is likely that Galileo planned to unite the pendulum and the clockwork mechanism towards the end of his life, but we have no proof that he ever managed to make this idea come alive.

This invention has given us the opportunity to make precise observations, and, noting the gap between two stars crossing the meridian, deduce their angle distance to the west or the east, knowing the speed of the celestial sphere's motion.

Picard was the first to appreciate the importance of this invention for astronomy, introducing correct timekeeping in the newly built Paris Observatory" ([65], page 177).

CHAPTER 1

Some necessary information related to astronomy and history of astronomy

1. THE ECLIPTIC. THE EQUATOR. PRECESSION

Let us consider the motion of the Earth along its solar orbit. It is usually considered that it isn't the Earth itself that rotates around the Sun, but rather the mass centre (gravity centre) of the Earth-Moon system, or the so-called barycentre. The barycentre is relatively close to the centre of the Earth as compared to the distance between the Earth and the Sun. The stipulations of the present work allow us to consider the orbital motion of the barycentre around the Sun identical to the orbital motion of the Earth itself.

Gravitational perturbations caused by planets cause constant rotation of the barycentre orbit plane. This rotation contains a certain primary sinusoidal compound with very high periodicity. It is complemented by certain minor variable fluctuations, which we shall ignore. This rotating orbital plane of the Earth is called the ecliptic plane.

Sometimes the term "ecliptic" is used for referring to the circumference where the ecliptic plane crosses the imaginary sphere of immobile stars. Let us assume that the centre of this sphere coincides with the centre of the Earth that lies on the ecliptic plane. In fig. 1.1. it is indicated as point *O*. We can disregard the motion of the Earth in relation to the distant stars and consider it the immobile centre of the stellar sphere. Our further references to celestial objects such as the Sun, stars etc shall imply the identification of said object with the point of its projection over the sphere of immobile stars.

The ecliptic rotates with time, which is why it is known as the "mobile ecliptic". In order to refer to the position of the mobile ecliptic at a given point in time, let us introduce the concept of instantaneous ecliptic for a given year or epoch. The conception and the properties of instantaneous spin vector pertain to the discipline of celestial mechanics. Fixed successive instantaneous ecliptics for different epochs are sometimes referred to as fixed ecliptics of said epochs. For instance, it is convenient to refer to the fixed ecliptic for 1 January 1900. The position of the mobile ecliptic for any given point in time can be specified in relation to a randomly chosen fixed ecliptic.

The Earth is considered a perfectly solid body in celestial mechanics. It is well known that a solid body possesses a so-called inertia ellipsoid, which is rigidly defined by its three semi-axes. The rotation of a solid body is characterised by the value and the spatial attitude of spin vector ω. Vector ω is sometimes referred to as the instantaneous axis of rotation. The semi-axes of the inertia ellipsoid are orthogonal, and can

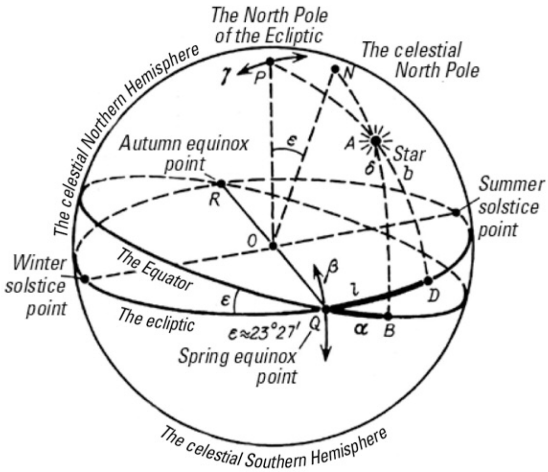


Fig. 1.1. The sphere of immobile stars. The ecliptic and equatorial coordinate systems.

therefore be used as an orthogonal system of coordinates. Thus, vector ω can be defined by the projections of x, y and z over the axes of inertia. The moments of body inertia relative to these axes shall be indicated as A, B and C, respectively. The rotation of a solid body is described in the dynamic equations of Euler-Poisson:

$$A\dot{x} + (C - B)yz = M_A$$
$$B\dot{y} + (A - C)xz = M_B$$
$$C\dot{z} + (B - A)xy = M_C$$

In the right part of the equations we have the projections of vector M, known as the external couple in relation to the mass centre, over the same axes. Moment M results from the effect of solar and lunar gravity on the ellipsoidal figure of the Earth. The Earth is usually considered a two-axial ellipsoid rather than triaxial – an ellipsoid of revolution, in other words.

The position of vector M in relation to the axes of inertia changes rapidly, and these changes are of a rather complex nature; however, the application of modern theories of lunar and telluric motion makes it feasible to calculate its evolution with sufficient precision for any moment in time. This allows us to solve the equation of Euler-Poisson, or calculate the evolution of vector ω.

The "Tables of the Motion of the Earth on its Axis and Around the Sun" ([1295]) compiled by the eminent American astronomer Simon Newcomb are used in order to account for all the irregularities inherent in the motion of the Earth.

The study of cases (solid body configurations) when the equations of Euler-Poisson can be solved with sufficient precision comprises an important area of modern theoretical mechanics, physics and geometry.

Let us consider vector ω of instantaneous Earth rotation. It defines the axis of rotation, or the instantaneous rotation axis. The points where it crosses the surface of the Earth are known as instantaneous poles of the Earth, whereas those where it crosses the celestial sphere, or the sphere of immobile stars, are known as celestial poles (North and South). Let us consider the plane orthogonal to the instantaneous rotation axis of the Earth that crosses the mass centre of the Earth. Its intersection with the surface of the Earth is known as the instantaneous equator of Earth rotation, and the intersection with the celestial sphere is referred to as the true celestial equator, celestial equator or equinoctial.

Fig. 1.1 depicts the celestial sphere. Its centre is marked O. P stands for the North Pole of the ecliptic, and N – for the celestial pole. The ecliptic and the equator have two intersection points, which are known as the vernal and autumnal equinox points (indicated as Q and R in fig. 1.1, respectively). The illustration also demonstrates the alterations of the star's coordi-

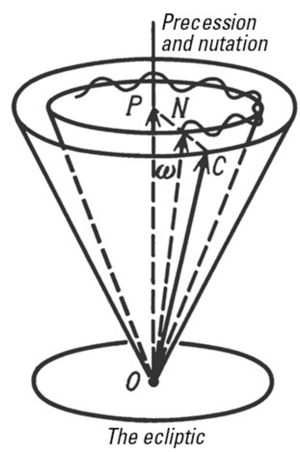


Fig. 1.2. Precession and nutation.

nates in relation to the two coordinate systems of the celestial sphere – equatorial and ecliptic.

Let us now consider a coordinate system that would not rotate together with the Earth, but be based on the ecliptic instead. The new coordinate system does not have to be orthogonal. The following axes are normally used for such coordinate systems:

1) normal to the ecliptic plane;

2) the intersection axis of the ecliptic and equatorial planes, or the equinoctial axis;

3) inertia axis *C*.

The projections of instantaneous angular velocity vector ω over these three axes are indicated as $\dot{\psi}$, $\dot{\theta}$ and $\dot{\varphi}$. We have thus expanded the Earth rotation rate into three components. What is their geometrical meaning? The value of $\dot{\psi}$, is known as the Earth precession rate. This component defines the circular conical motion of precession axis *C*, or the third axis of inertia, around the normal *OP*, as shown in fig. 1.2. Vector $\omega = ON$ follows this conical rotation. Let us point out the close proximity of vectors ω and *OC*. For approximated calculations we can assume vector ω to coincide with axis *OC*.

Owing to precession, the equinox axis, or the intersection of the ecliptic and the equator, rotates within the ecliptic plane. The rotation of $\dot{\theta}$ affects the inclination of axis *OC* towards the ecliptic to a certain extent. Finally, the value of $\dot{\varphi}$ defines the rate of the Earth's rotation around axis *OC*. In theoretical mechanics the value of $\dot{\varphi}$ is known as proper rotation rate. It is much higher than the angular velocities of $\dot{\psi}$ and $\dot{\theta}$. From the point of view of theoretical mechanics, this circumstance reflects the fact that the stable rotation of a solid body occurs around the axis that happens to be the closest to the axis of maximal inertia moment, or the shortest axis of the inertia ellipsoid. Let us remind the reader that the Earth is somewhat flattened at the poles.

Thus, $\omega = \dot{\psi} + \dot{\theta} + \dot{\varphi}$ (+ standing for the summation of vectors). Each velocity ($\dot{\psi}$, $\dot{\theta}$ and $\dot{\varphi}$) contains a single constant (or nearly constant) component as well as a great many small periodic ones, commonly referred to as nutations. If we overlook them, we shall come up with the following model of Earth rotation.

1. Constant velocity component $\dot{\psi}$ is called longitudinal precession. It moves axis *OC* along the circular cone with the approximate annual velocity of 50" (see fig. 1.2). The equinoctial axis moves clockwise along the ecliptic as seen from the side of its north pole. The precession vector is directed at the ecliptic's South Pole.

2. Constant velocity component $\dot{\theta}$ approximates 0.5" per year as of today.

3. Constant velocity component $\dot{\varphi}$ is the average proper Earth motion velocity value with the periodicity of one day anticlockwise around axis *AC* (as seen from the North Pole of the Earth).

Let us note that axis *OP*, which is the normal towards the ecliptic plane, belongs to the same plane as vector ω, which represents the instantaneous angle velocity of the Earth, and axis *OC*, or the third axis of inertia. This plane rotates around axis *OP* due to precession.

Nutational components inherent in velocities ($\dot{\psi}$, $\dot{\theta}$ and $\dot{\varphi}$) distort the above model – therefore, vector ω doesn't follow an ideal conical trajectory, but a rather erratic wavy one instead, which approximates the shape of a cone. The trajectory of the vector's end point is drawn as a wavy line in fig. 1.2.

The two circumferences that pertain to the celestial sphere (the equator and the ecliptic) intersect at the angle of $\varepsilon = +23°27'$ in two points – *Q* and *R*, qv in fig. 1.1. The Sun crosses the equator twice in these points over the course of its annual voyage along the ecliptic. Point *Q*, which is where the Sun enters the Northern Hemisphere, is the point of the vernal equinox. This is the point where the respective durations of daytime and night time equal one another everywhere on the Earth. Point *R* corresponds to the autumnal equinox (see fig. 1.1).

The mobile ecliptic is in constant rotation. Therefore, the vernal equinox point constantly shifts alongside the equator, simultaneously moving along the ecliptic as well. The velocity at which the equinox point travels along the ecliptic is the actual longitudinal precession. The shift of the equinox points produces the equinox precession effect (see fig. 1.1).

2. EQUATORIAL AND ECLIPTIC COORDINATES

In order to record the observations of celestial bodies, one needs a convenient coordinate system that would allow one to fix the respective positions of celestial bodies. There are several such coordinate

systems – first and foremost, the equatorial coordinates, which are defined as follows.

In fig. 1.1 we see the North Pole indicated as *N* and the celestial equator, which contains arc *QB*. We can estimate the plane of the celestial equator to coincide with the plane of the Earth equator, given that the centre of the Earth corresponds to point *O*, which stands for the centre of the celestial sphere. Point *Q* is the vernal equinox point. Let point *A* represent a random immobile star. Let us consider meridian *NB*, which crosses the North Pole and star *A*. Point *B* is the intersection of the meridian with the equatorial plane. Arc $QB = \alpha$ corresponds to the equatorial longitude of star *A*. This longitude is also known as "direct ascension". The direction of the arc is opposite to the motion of *Q*, which is the vernal equinox point. Therefore, direct ascensions of stars attain greater values over the course of time due to precession.

Meridian arc $AB = \delta$ corresponds to the equatorial latitude of star *A*, which is also referred to as the declination of star *A*. If we are to disregard the fluctuations of the ecliptic, the declinations of the stars located in the Northern Hemisphere diminish with time due to the motion of vernal equinox point *Q*. The declinations of the stars in the Southern Hemisphere slowly grow with time.

The daily motion of the Earth does not alter the declinations of the stars. Direct ascensions change in a uniform fashion and are affected by the Earth's rotation velocity.

The ecliptic coordinate is also rather popular, and it was used very widely in the ancient star catalogues.

Let us consider the celestial meridian that crosses the ecliptic pole *P* and star *A* (see fig. 1.1). It crosses the ecliptic plane in point *D*. Arc *QD* corresponds to ecliptic longitude *l* in fig. 1.1, and arc *AD* represents ecliptic latitude *b*. Precession makes arc *QD* grow by circa one degree every 70 years, which results in the uniform growth of the ecliptic longitudes.

If we disregard the fluctuations of the ecliptic, we can consider ecliptic latitudes *b* stable as a first approximation. This is the very thing that made ecliptic coordinates so popular with the mediaeval astronomers. The advantage of the ecliptic coordinates over the equatorial ones is that the value of *b* is constant, whereas the value of *l* grows with the course of time as a result of precession. The alterations of equatorial coordinates caused by precession conform to much more complex formulae, which account for the orthogonal turn of the ecliptic that connects it to the equator.

It is for this very reason that mediaeval astronomers tried to compile their catalogues with the use of ecliptic coordinates, notwithstanding that equatorial coordinates are easier to calculate by observations, since such calculations do not stipulate to define the ecliptic plane. The position of the ecliptic depends on the motion of the Earth around the Sun and requires the use of sophisticated methods for its calculation, which, it turn, lead to additional systematic errata in the coordinates of all stars. The discovery of the fact that the ecliptic fluctuates over the course of time led to the use of equatorial star coordinates in catalogues instead of the ecliptic system. This system is still used – the "advantage" of the ecliptic system is a thing of the past.

3.
THE METHODS OF MEASURING EQUATORIAL AND ECLIPTIC COORDINATES

Let us briefly consider a number of actual methods used for the estimation of equatorial and ecliptic coordinates. We shall relate a certain simple geometric idea that such measuring instruments as the sextant, the quadrant and the transit circle employ in their construction.

Let us assume that observer *H* is located in point φ on the surface of the Earth (see figs. 1.3 and 1.4). It is rather easy to define line HN' that is oriented at the celestial North Pole and the parallel line *ON*. Next we have to define the meridian that crosses point *H* and mount a vertical wall on Earth surface that shall go along this meridian, qv in figs. 1.3 and 1.4. Marking the direction of the celestial pole on this wall as HN', we can also indicate the equatorial like HK', which is parallel to *OK*, by means of laying an angle $\frac{\pi}{2}$ from direction HN'. Right angle $N'HK'$ can be divided into degrees, which gives us an astronomical instrument for angular measurements – a quarter of a divided circle positioned vertically. Modern meridian instruments are based on this instrument as well – it can be used for measuring star declinations, or their equatorial latitudes, and also for marking the mo-

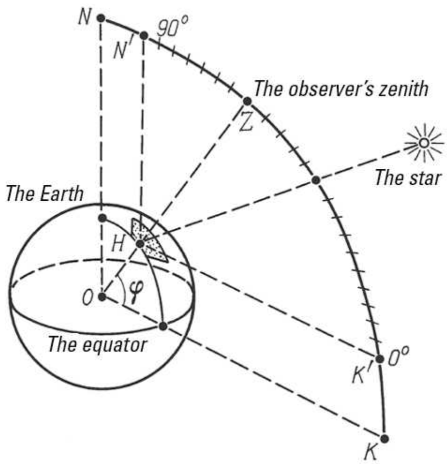


Fig. 1.3. The principle of stellar coordinate measurement.

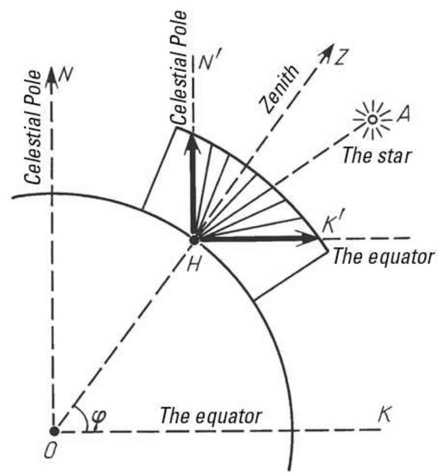


Fig. 1.4. Measuring the coordinates of a star that passes a meridian.

ments when stars cross a given meridian, or the so-called vertical.

A series of independent consecutive measurements makes it feasible to estimate the equatorial plane for the latitude of observation with high enough precision. At the same time, as it is obvious from the above elementary celestial mechanics, a measurement of longitudes requires a fixation of moments when the stars cross the meridian. This requires either a sufficiently precise chronometer, or an auxiliary device providing for fast measurements of longitudinal distances between the star that interests us and a fixed meridian. At any rate, longitudinal measurements are a substantially more subtle operation. Therefore it is to be expected that mediaeval astronomers' measurements of direct ascensions are cruder than their declination measurements.

In order to measure the ecliptic coordinates of stars observer *H* must assess the celestial position of the ecliptic first. This operation is sophisticated enough and stipulates a good understanding of primary elements of solar and telluric motion. Ancient methods of measuring the declination angle between the ecliptic and the equator as well as the position of the equinoctial axis with the aid of the armillary sphere or the astrolabe are described in [614] and a wealth of other sources. It has to be noted that in order to measure the ecliptic coordinates of a series of stars one needs a timekeeping device of some sort in order to compensate the daily rotation of the Earth and keep the orientation at the equinoctial point constant.

The obvious complexity of this task led to the following: for actual calculations of ecliptic coordinates astronomers would either use formulae of the celestial sphere's rotation or celestial globes with equatorial and ecliptic coordinate grids. The knowledge of equatorial coordinates would allow calculating their ecliptic equivalents. Naturally enough, there were inevitable errata resulting from lack of sufficient precision in the estimation of the comparative positions of the ecliptic and the equator, as well as the attitude of the equinoctial axis.

This very concise discussion of methods used for the measurement of ecliptic coordinates permits the estimation that the mediaeval astronomers are most likely to have used the following algorithm:

1) They would calculate the equatorial coordinates, the latitudinal measurements being more precise than the longitudinal.

2) Next they would estimate the position of the ecliptic and the equinoctial axis in relation to the equator.

3) Finally they would convert the equatorial coordinates into their ecliptic equivalents with the aid of special measurement instruments or trigonometric

formulae (or, alternatively, with the use of a celestial globe with a double coordinate grid).

Moreover, since all the ancient measurement tools were inevitably installed upon the surface of the Earth, the above algorithm is the only real method of calculating the ecliptic stellar coordinates. Since a measuring instrument installed on the surface of the Earth takes part in daily rotation of the Earth, the instrument in question is invariably tied to the equatorial coordinate system.

The application of our statistical methods to the data provided by the Almagest catalogue yielded a confirmation of the above algorithm's usage, as we shall demonstrate below.

4. THE MODERN CELESTIAL SPHERE

In order to date an old star catalogue by the numeric values of stellar coordinates contained therein, we must be able to calculate the positions of stars on the celestial sphere for various points of time in the past. The information that we use for reference is the existing description of the celestial sphere in its modern state. The only data of importance are the coordinates of stars, as well as their magnitude and proper motion rate.

Jumping ahead, we can remark that the dating method that we suggest is only applicable if the respective positions of stars alter with the course of time. The rotation of the entire celestial sphere resulting from a transition to another coordinate system cannot be used for the purposes of independent dating. We shall discuss this in more detail below.

Let us discuss the characteristics of the stars that we shall refer to in our research.

The magnitude of a star in a modern catalogue is the number that represents its brightness. The lower the value, the brighter the star. There is an old tradition of indicating said values in star catalogues. The Almagest contains the magnitude values of all the stars it lists. The brightest stars are indicated as the stars of the first magnitude, the less bright ones correspond to the second magnitude and so on. Modern catalogues use the same scale for referring to the brightness of a given stars. However, stellar magnitudes can also be expressed as fractions. For example, Arcturus, which possesses the magnitude of 1 in the Almagest, has the magnitude of 0.24 in "The Bright Star Catalogue", a modern source ([1197]), and Sirius, also a star of the first magnitude in the Almagest, possesses the magnitude of –1.6 in the modern catalogue. Thus, Sirius is brighter than Arcturus, although Ptolemy believed them to be equally bright.

The matter might be that in the antiquity the brightness (or the magnitude) of a star was estimated by the observer in a very approximated fashion. Nowadays stellar magnitude is estimated with the photometric method. A comparison of stellar magnitudes contained in the Almagest to their modern precise values as given in the work of Peters and Knobel ([1339]) demonstrates that the discrepancy doesn't usually exceed 1 or 2 measurement units.

In our calculations of actual positions of stars in the past we were primarily referring to the bright star catalogue ([1197]), which contains the characteristics of circa 9000 stars up to the eighth stellar magnitude. Let us remind the reader that one can only see the stars whose magnitude is up to 6 or 7 with the naked eye. According to Ptolemy's claim, the Almagest star catalogue contains all the stars from the visible part of the sky up to the 6th magnitude.

Ptolemy was exaggerating – there are more stars with magnitudes of 6 and less in the visible part of the sky than in the Almagest catalogue. This is one of the reasons why the attempts to identify the Almagest stars with the stellar positions calculated "in reverse" lead to ambiguities (see Chapter 2 for more details). On the other hand, it would be natural to assume that all the stars that were actually observed by Ptolemy or his predecessors still exist and can be found in the modern catalogue ([1197]).

J. Bayer, a prominent XVII century astronomer, suggested a new system of referring to stars in a constellation. He suggested using letters of the Greek alphabet instead of a verbal description of a given star's position in a constellation. The brightest star of a constellation would be indicated by letter α, the second brightest one – by letter β, and so on. Later on, Flamsteed (1646-1720) devised a special numeration for stars in a constellation – more specifically, the westernmost star of a constellation was indexed as 1, the next one to the east – as 2, and so on. Flamsteed's numbers and Bayer's letters are often used in combi-

nation for referring to a star (32 α Leo and so on). Apart from that, some of the stars have individual names. Such "named" stars are comparatively rare – individual names were only assigned to stars that had special significance in ancient astronomy. For instance, 32 α Leo is called Regulus.

We have used the following characteristics of stars from the modern catalogue ([1197]):

1. *Direct ascension of a star* for the epoch of 1900, which is transcribed as α_{1900} below, expressed in hours, minutes and seconds.

2. *The declination of a star* for the same epoch transcribed as δ_{1900} and measured in degrees, arc minutes and seconds.

3. *Stellar magnitude.*

4. *Proper motion rate of a given star*. The proper motion rate is comprised of two elements, the first one being the star declination fluctuation rate and the second – the rate of its direct ascension alteration. However, the coordinate grid of longitudes and latitudes on a sphere isn't uniform. The distances between adjacent meridians diminish closer to the poles; therefore, the stellar velocity component of direct ascension gives one a wrong idea of the true, or "visible" velocity of a star on the celestial sphere in the direction of the parallel. Therefore, some modern star catalogues give the stellar velocity component of the direct ascension reduced to the equator. This means the value is multiplied by the declination cosine, which makes it possible to interpret it as the local Euclidean length of the stellar velocity vector projection over the equator (the parallel). This permits a comparison of the first stellar velocity components regardless of their proximity to the pole. If the velocities aren't reduced in this fashion, such comparisons require additional calculations.

Catalogues BS4 ([1197]) and BS5 (online source) that we have used, the velocities are reduced to the equator, which isn't the case with catalogues FK4 ([1144]) and FK5 (online source). Oddly enough, this fact isn't always mentioned in the descriptions of astronomical catalogues. The form of the direct ascension velocities has to be estimated from their actual numeric values.

The values of proper star motion rates are rather small. They don't normally exceed 1" per year – the fastest of the stars visible to the naked eye, such as o^2 Eri, μ Cas, move at the rate of 4" per year.

The trajectories of stellar motion for the time intervals that interest us (2-3 thousand years) can be considered straight, which means that each of the star's coordinates on the celestial sphere change evenly. This approximation is only valid for areas that lay at some distance from the pole, obviously enough.

The standard coordinate system for the celestial sphere as given in the modern star catalogues is customarily based on the equatorial coordinates for the epochs of 1900, 1950 and 2000 A.D. We have chosen the system of equatorial coordinates for the beginning of 1900 A.D. Further calculations and coordinate system conversions for a given epoch *t* were based on this system.

First and foremost, in order to date the Almagest catalogue we shall need the coordinates of stars with high proper motion rates. Naturally, we shall only consider the fast stars that are believed to be listed in the Almagest.

We have refrained from discussing the issue of whether or not the Almagest stars were identified correctly. We shall consider it in detail below. In order to solve the identification problem we must know whether a given star had an individual name in the ancient catalogues. The information about the mediaeval names of stars was taken from catalogues BS4 ([1197]) and BS5 (online source).

In order to date the Almagest catalogue by proper motion rates we shall require the following two lists of stars from the modern catalogues. We shall merely describe them herein; the actual lists can be found in Annex 1.

We shall refer to the first list as to the list of "fast" stars. In the first stage of said list's compilation we have selected all the stars whose speed by one of the coordinates at least is greater than 0.1" per year. This list was subsequently reduced to the stars that either have Bayer's Greek letter or Flamsteed's number in their name. Thus, we have rejected the stars that are a priori useless for the dating for the Almagest. The matter is that nearly every star identified by the astronomers as one of the Almagest stars has an index in either Bayer's or Flamsteed's system, or both; also, if a star from the Almagest is identified as one that lacks such indices, this identification is always rather ambiguous ([1339]). The reason is clear enough. The catalogues of Bayer and Flamsteed were already com-

piled in the epoch of early telescopic observations, or the XVII-XVIII century. If a given star is omitted from those catalogues, it is either too dim or too difficult to tell apart from the celestial objects in its immediate vicinity.

There may be other complications in the same vein; therefore, one can hardly assume that a star of this sort can be veraciously identified as an Almagest star and that its position was measured with sufficient precision by the "ancient" astronomers.

The above selection gave us a list of "fast" stars visible with the naked eye, which can be found in modern star catalogues and identified as Almagest stars. Quite naturally, the veracity of such identifications requires a separate research. We shall consider this problem below.

Our list of "fast" stars visible to the naked eye can be found in Table P1.1 of Annex 1.

The second list of stars is the list of named stars. It is contained in Tables P1.2 and P1.3. In Table P1.2 the stars are arranged by names, and in Table P1.3 – by respective numbers from the Bright Star Catalogue ([1197]). This list contains all the stars which have individual names according to BS4 ([1197]), or which had such names in the past (Arcturus, Aldebaran, Sirius etc).

The lists of fast and named stars intersect – the same star can have a visible proper motion rate and an individual name. Such stars are the most useful for the dating of the Almagest.

5. "REVERSE CALCULATION" OF OBJECTS' POSITIONS ON THE CELESTIAL SPHERE. THE FORMULAE OF NEWCOMB-KINOSHITA

5.1. Necessary formulae

Having the modern coordinates and proper motion rates of stars at our disposal, we can compile a sufficiently precise star catalogue for any epoch in the past. By "sufficiently precise" we mean the precision that corresponds to modern astronomical theories, which is quite sufficient for our purposes. Such precision can be considered absolute in comparison to that of the old catalogues.

We had to perform retroactive star position calculations quite a few times for different epochs. We would first calculate the positions of stars on the celestial sphere for year t in coordinates α_{1900} and δ_{1900}, and then convert those into ecliptic coordinates l_t and b_t for epoch t.

Let us cite the necessary formulae that allow the conversion of coordinates α_s and δ_s into coordinates l_{s0} and b_{s0} for any epochs s and s_0. These formulae account for precession and proper star motion. Said formulae, as well as fig. 1.5, which illustrates them, were taken from [1222]. They are based on Newcomb's theory as modified by Kinoshita. The actual coordinate conversion procedure is described in the next section (5.2). In these formulae time moments s_0 and s are counted backwards from the epoch of 2000 A.D. in Julian centuries, and $\theta = s_0 - s$. See fig. 1.5.

$$\begin{aligned}\varphi(s, s_0) &= 174°52'27{,}66'' + 3289{,}80023'' s_0 + 0{,}576264'' s_0^2 \\ &- (870{,}63478'' + 0{,}554988'' s_0)\theta + 0{,}024578''\theta^2; \end{aligned} \quad (1.5.1)$$

$$\begin{aligned}\kappa(s, s_0) &= (47{,}0036'' - 0{,}06639'' s_0 + 0{,}000569 s_0^2)\theta \\ &+ (-0{,}03320'' + 0{,}000569'' s_0)\theta^2 + 0{,}000050''\theta^3; \end{aligned} \quad (1.5.2)$$

$$\begin{aligned}\varepsilon_0(s, s_0) &= 23°26'21{,}47'' - 46{,}81559'' s_0 \\ &- 0{,}000412'' s_0^2 + 0{,}00183'' s_0^3 \end{aligned} \quad (1.5.3)$$

$$\begin{aligned}\varepsilon_1(s, s_0) &= \varepsilon_0(s, s_0) + (0{,}05130'' - 0{,}009203'' s_0)\theta^2 - 0{,}007734''\theta^3; \\ \varepsilon(s, s_0) &= \varepsilon_0(s, s_0) + (-46{,}8156'' - 0{,}00082'' s_0 + 0{,}005489'' s_0^2)\theta \\ &+ (-0{,}00041'' + 0{,}005490'' s_0)\theta^2 + 0{,}001830''\theta^3; \\ \psi(s, s_0) &= (5038{,}7802'' + 0{,}49254'' s_0 - 0{,}000039'' s_0^2)\theta \\ &+ (-1{,}05331'' - 0{,}001513'' s_0)\theta^2 - 0{,}001530''\theta^3; \\ \chi(s, s_0) &= (10{,}5567'' - 1{,}88692'' s_0 - 0{,}000144'' s_0^2)\theta \\ &+ (-2{,}38191'' - 0{,}001554'' s_0)\theta^2 - 0{,}001661''\theta^3; \end{aligned}$$

$$\begin{aligned}\Psi(s, s_0) &= (5029{,}0946'' + 2{,}22280'' s_0 + 0{,}000264'' s_0^2)\theta \\ &+ (1{,}13157'' + 0{,}000212'' s_0)\theta^2 + 0{,}000102''\theta^3. \end{aligned} \quad (1.5.4)$$

Let us however note that the discrepancies between the corollaries made according to the actual theory of Newcomb and its modification made by Kinoshita ([1222]) that we have used are of no consequence insofar as our purposes are concerned. For any time moment t of the historical interval under consideration (between 600 B.C. and 1900 A.D.) the discrepancies between the ecliptic coordinates of a star calculated according to Newcomb's theory and those obtained with the use of its modified version ([1222]) are negligibly small in comparison to the errors of the Almagest. We have used [1222], since it gives the for-

mulae for precession compensation in a format convenient for computer calculations.

5.2. The algorithm for calculating past positions of stars

Let us provide a detailed description of the algorithm used for the calculation of star catalogue $K(t)$, which reflects the condition of the celestial sphere for year t with sufficient precision, according to Newcomb's theory. Here t is a randomly chosen epoch from the historical interval under consideration (namely, one between 600 B.C. and 1900 A.D.). Epoch t is calculated backwards into the past from the epoch of 1900 in Julian years, in other words, $t = 1$ corresponds to the epoch of 1800, $t = 10$ – to the epoch of 900 A.D., $t = 18$ – to 100 A.D., etc. The discrepancy of several days that results from the differences between the Julian and the Gregorian calendar, and leads to the situation where the epoch of 100 A.D., for instance, fails to coincide with the epoch of 1 January 100 A.D. is of no importance whatsoever.

The calculated star catalogues $K(t)$ shall serve us for comparison with the old catalogue under study (such as the Almagest) with different values of t. Here t shall stand for a random assumed dating of an old catalogue. Thus, calculated catalogues $K(t)$ must be transcribed in ecliptic coordinates for epoch t. As it has been pointed out, all known old catalogues are compiled in ecliptic coordinates, be it Ptolemy's Almagest or the catalogues of As-Sufi, Ulugbek, Copernicus, Tycho Brahe etc.

Let us assume that the modern equatorial coordinates of a star in a catalogue (such as [1197]) are $\alpha^0 = \alpha^0_{1900}$, $\delta^0 = \delta^0_{1900}$. These coordinates reflect the position of the star in question for 1900 A.D. in the spherical coordinate system, whose equator corresponds to the Earth's equator in 1900 A.D. The equator is defined by the plane that is orthogonal to the axis of the Earth's rotation. Let us remind the reader that this plane's position changes over the course of time. We have to calculate the coordinates l_t, b_t, or the spherical coordinates whose equator coincides with the ecliptic, or the plane of the Earth's rotation around the Sun for epoch t. We should do the following for this purpose.

Step 1. We have to calculate the star's coordinates $\alpha^0(t)$, $\delta^0(t)$ for time moment t in the equatorial coordinate system for 1900 A.D. Bear in mind that the position of the stars on the celestial sphere changes over the course of time in relation to any fixed system of coordinates. The required calculations of the star's position are based on the known proper motion rates v_α, v_δ of the star by each of the coordinates α_{1900}, δ_{1900} (see Table 4.1, columns 5 and 6). We shall come up with the following for non-reduced proper motion rates:

$$\alpha^0(t) = \alpha^0_{1900}(t) = \alpha^0 - v_\alpha \cdot t,$$
$$\delta^0(t) = \delta^0_{1900}(t) = \delta^0 - v_\delta \cdot t.$$

Indeed, we can consider the proper motion rates of each star by the coordinates α_{1900}, δ_{1900} to be constant. The minus in the formulae cited above results from the retroactive nature of calculations; the velocity rate symbols v_α, v_δ correspond to the normal flow of time.

Before we can actually use this formula, we have to convert all the source values into a single measurement system. For instance, we can measure $\alpha^0(t)$ and $\delta^0(t)$ in radians, and the velocities v_α, v_δ – in (rad ÷ year) $\cdot 10^{-2}$.

Step 2. We have to shift from coordinates α_{1900}, δ_{1900} to coordinates l_{1900}, b_{1900}. We shall come up with coordinates $l^0(t)$, $b^0(t)$ of our star for the moment t in spherical coordinates based on the ecliptic of the epoch of 1900 A.D. This is what we get:

$$\begin{aligned} \sin b^0(t) &= -\sin\alpha^0(t)\cos\delta^0(t)\sin\varepsilon^0 + \sin\delta^0(t)\cos\varepsilon^0, \\ \tan l^0(t) &= \frac{\sin\alpha^0(t)\cos\delta^0(t)\cos\varepsilon^0 + \sin\delta^0(t)\sin\varepsilon^0}{\cos\alpha^0(t)\cos\delta^0(t)}, \\ \varepsilon^0 &= 23°27'8{,}26''. \end{aligned} \tag{1.5.5}$$

These formulae permit an unequivocal reconstruction of the values of $\beta^0(t)$ and $\alpha^0(t)$, since $-90° < b^0(t) < 90°$ and $|l^0(t) - \alpha^0(t)|$ τ $90°$. The value of ε^0 corresponds to the declination angle between the ecliptic of 1900 A.D. and the equator of 1900 A.D. We refer the reader to the formula of 1.5.3, where one has to let $s^0 = -1$ in order to make the transition between 2000 A.D. and 1900 A.D.

Step 3. We have to make a shift from coordinates l_{1900}, b_{1900} to the auxiliary coordinates l^1 and b^1, which are also tied to the ecliptic of 1900. However, they have a different longitudinal reference point, which coincides with the intersection of the ecliptic of

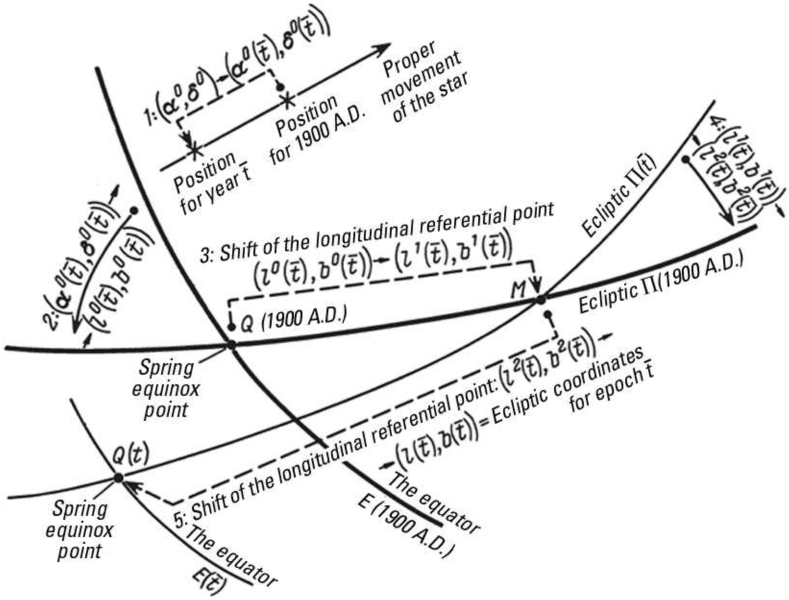


Fig. 1.6. The sequence of steps that we use for reverse calculations of stellar positions and their past coordinates.

1900 A.D. and that of epoch t, or Π_{1900} and $\Pi(t)$. This transition conforms to the following formulae:

$$l^1(t) = l^0(t) - \varphi,$$
$$b^1(t) = b^0(t)$$
$$\varphi = 173°57'38.436'' + 870.0798''t + 0.024578''t^2. \quad (1.5.6)$$

Arc φ between the vernal equinox point of 1900 on the ecliptic Π_{1900} and the intersection of Π_{1900} and $\Pi(t)$ conforms to the formula (1.5.1) if we're to assume that $s_0 = -1$ and $\theta = -t$. Then the ecliptic $\Pi(s_0)$ in fig. 1.5 shall correspond to the ecliptic Π_{1900}. Ecliptic $\Pi(s)$ in fig. 1.5 shall represent the ecliptic of epoch t, which is of interest to us. Indeed, the time t is counted backwards from 1900 A.D. in centuries, whereas the remainder of $\theta = s - s_0$ is counted forwards from epoch s_0, also in centuries. Since we have agreed on $s_0 = -1$, which corresponds to 1900 A.D. (2000 – 100 = 1900), we have to choose $\theta = -t$ in order to make the epoch $s = s_0 + \theta$ correspond to epoch t under consideration in our formula (1.5.1).

Step 4. Next we have to make the transition from coordinates l^1, b^1 to coordinates l^2, b^2. These are spherical coordinates tied to the ecliptic $\Pi(t)$, whose only difference from the ecliptic coordinates l_t, b_t is due to the choice of the longitudinal reference point. In coordinates l^2, b^2 this point corresponds to the intersection of ecliptics Π_{1900} and $\Pi(t)$. The formulae of transition from l^1, b^1 to l^2, b^2 correspond to the formulae (1.5.5). Instead of ε^0 we have to take the angle ε^1 between ecliptics $\Pi(t)$ and Π_{1900}:

$$\varepsilon^1 = -47.0706''t - 0.033769''t^2 - 0.000050''t^3.$$

This expression is derived from the formula (1.5.2) where $s = -1$ and $\theta = -t$.

Step 5. Finally, we have to make the transition from coordinates l^2, b^2 to the ecliptic coordinates l_t, b_t. This transition conforms to the following formulae:

$$l_t = l^2 + \varphi + \Psi, \quad b_t = b^2,$$

where φ is defined in (1.5.6) and Ψ is defined by formula (1.5.4) with $s^0 = -1$ and $\theta = -t$, therefore

$$\Psi = -5026.872''t + 1.1314''t^2 + 0.0001''t^3.$$

The sequence of steps 1-5 as described above is illustrated in fig. 1.6.

Let us conclude by pointing out that all the calculations necessary for the dating of a given star catalogue can be performed without accounting for the Newcomb-Kinoshita theory. We shall consider this in more detail below. The Newcomb-Kinoshita theory is only used in order to obtain additional information concerning the errata in the estimation of the ecliptic plane made by the author of the catalogue. The value of these discrepancies is the auxiliary factor that confirms the correctness of our corollaries. See Chapters 6 and 7.

6. ASTROMETRY. ANCIENT ASTRONOMICAL MEASUREMENT INSTRUMENTS OF THE XV-XVII CENTURY

In Section 3 we have considered the general conception of angular measuring devices used in astronomy, which is important to us since it enables us to estimate the position of the equatorial line on the celestial sphere with sufficient precision.

Let us assume that the observer's line of eyesight is directed along half-line *HK′*, which moves along the line of the equinoctial in its daily rotation without any tergiversation. The attitude of half-line *HK′* will naturally depend on the geographical latitude. We can define the plane *HLM*, an orthogonal quadrant parallel to the equatorial plane, which crosses the celestial sphere precisely along the equinoctial, qv in fig. 1.7. It is therefore possible to construct a stationary device in said point of telluric surface, oriented by the north-south meridian, which allows marking the equator on the celestial sphere visually. This permits precise estimations of equatorial stellar latitudes – during their crossing of the quadrant's vertical plane, for instance. As we have already pointed out, the measurement of equatorial latitudes was hardly a complicated task for a professional astronomer of the XIV-XVI century. It required nothing but accuracy and sufficient time for observations. In particular, it has to be expected that a careful observer could not make a grave systematic error in the estimation of stellar declinations for a given year.

Now let us see how the simple general idea described above was implemented in real mediaeval instruments.

The first instrument is the meridian circle, or the so-called transit circle as described by Ptolemy (see fig. 1.8). The instrument looked like a flat metal ring of a random radius installed on a reliable support vertically in the plane of the local meridian. The circle was graded (into 360 degrees, for example). Another ring of a smaller diameter was placed inside the larger ring; it could rotate freely, remaining in the same plane as the larger ring (fig. 1.8). There are two little metallic plates with pointers attached to two opposing points on the inner ring (marked *P* in fig. 1.8); the pointers point at the grades found on the external ring. The device is installed in the plane of the local meridian with the aid of a level and the meridian line whose direction is defined by the shadow of a vertical pole at midday. Then the zero mark on the external ring of the instrument is synchronised with the local zenith.

The instrument described above can be used for measuring the height of the Sun at given latitude. One must quickly turn the inner ring at midday until the shadow of one plate *P* covers the other plate *P* completely. In this case, the position of the pointers on the plates shall tell us the height of the Sun with the aid of the grade marks on the external ring. It has to be pointed out that the instrument's indications are to be read after one fixes the plates in their proper positions. This tells one the height of the Sun already after midday. Moreover, the meridian circle can measure the angle between the ecliptic and the equator.

The second instrument is the astrolabon as described by Ptolemy, which is more frequently referred to as "astrolabe" in our days. The latter term is mediaeval in origin. According to the Scaligerian history of astronomy, the meaning of the term "astrolabon" has been changing over the course of time. We are told that "in deep antiquity", or around the very beginning of the new era, the term "astrolabon" was used for referring to the instrument that we shall describe shortly. Ptolemy used one of those. However, in the Middle Ages the instrument in question was already known as the armillary sphere, or "armilla". Some modern astronomers are of the opinion that Ptolemy describes the armillary sphere or the astrolabon in his "Almagest", and not the actual astrolabe (see [395], for instance). According to Robert Newton, a renowned astronomer, "it is likely that around the end of the Middle Ages the term 'astrolabe' referred

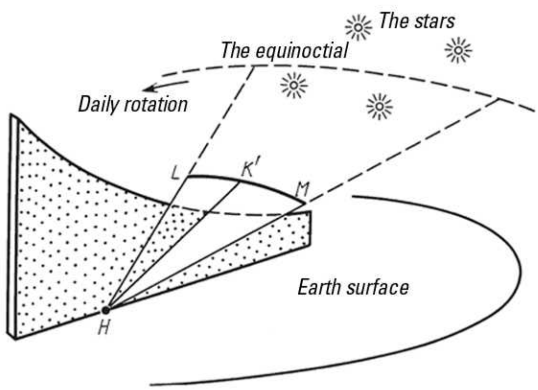


Fig. 1.7. Measuring the latitude of a star.

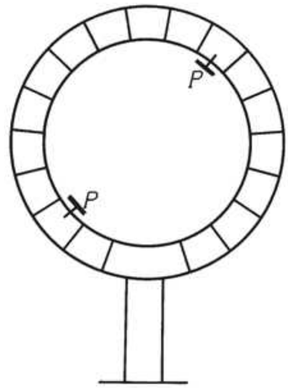


Fig. 1.8. The armillary circle.

to the device used for measuring the height of a celestial body above the horizon. As for the device we describe herein [in accordance with Ptolemy's indications – Auth.], by that time it was better known as the armillary sphere, which is the distant ancestor of the modern telescopes' bearings" ([614], page 151).

In order to avoid confusion with terms, we shall describe the two instruments separately – Ptolemy's astrolabon and the astrolabe, or the mediaeval instrument whose name is virtually identical to that of Ptolemy's astrolabon. The primary elements of the astrolabon's (armilla's) construction are shown in fig. 1.9. In fig. 1.10 we see the principal scheme of the mediaeval armillary sphere. Fig. 1.11 shows us "the mediaeval armillary sphere – of Ptolemy's type, according to historians. Its diameter equals 1.17 metres. This instrument was manufactured when Ptolemy's epoch was already considered ancient – it belonged to Tycho Brahe, the famed XVI century astronomer" ([1029], page 13). The implication is that astronomical instruments remained the same for fifteen hundred years. As we can see, the instruments of the "ancient" Ptolemy from the second century A.D. and the XVI century scientist Tycho Brahe were almost identical, as though they were made in the same mediaeval workshop. An ancient drawing of Tycho Brahe's large armillary sphere can be seen in fig. 1.12.

We must now describe the correct use of this instrument to the reader and also relate the astronomical principles of its construction. The main element of the armillary sphere comprises two metallic rings, perpendicular to one another and rigidly joined to-

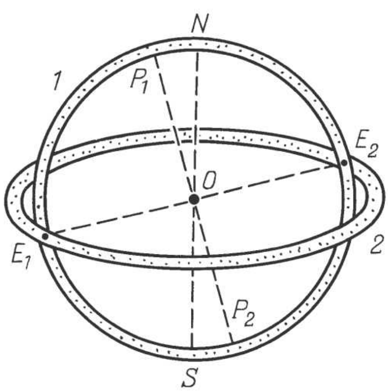


Fig. 1.9. A scheme of the astrolabon (armilla).

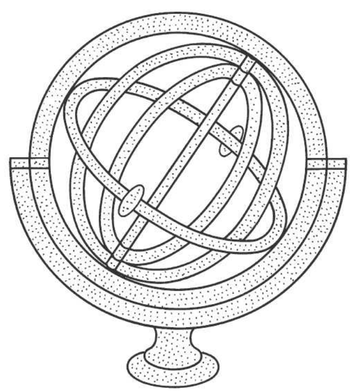


Fig. 1.10. A scheme of the armillary sphere.

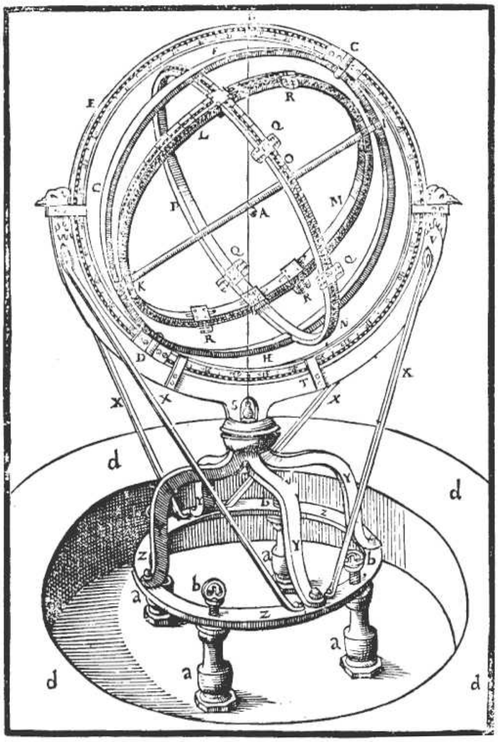


Fig. 1.11. The armillary sphere made in the XVI century; it used to belong to Tycho Brahe (1598). It is almost indistinguishable from the instrument used by the "ancient" Ptolemy in the II century A. D. These instruments are most likely to date to the same epoch – the XV-XVII century. Taken from [1029], page 13.

gether in points E_1 and E_2. Let us henceforth refer to the rings as the "first" and the "second" (see fig. 1.9). The first ring rotates around the axis *NS*, which is parallel to the axis of telluric rotation. The centre of both rings is point *O*; P_1P_2 is the perpendicular to the second ring's plane.

Let us describe how one uses the armilla in order to measure the angle between the ecliptic and the equator, for example. The most appropriate time for such measurements falls over the day of summer or winter solstice. The corresponding point on the orbit of the Earth is marked O' in fig. 1.13. It doesn't matter whether it corresponds to summer or winter solstice. Let us consider the plane that crosses the radial vector CO', where *C* is the Sun, and the Earth axis is indicated as NO'. Since O' is the solstice point, this plane will be orthogonal to the plane of the ecliptic, crossing the Earth surface along the meridian, qv in fig. 1.13.

Let us assume that the armilla is installed somewhere along this meridian. The instrument can be located anywhere on the surface of the Earth, but the measurements must begin at midday, which is when the instrument shall be on the meridian that is the intersection of said plane and the surface of the Earth. We assume the observer to know the direction of the Earth axis in this part of the Earth; therefore, the armilla's *NO* axis shall be oriented in this direction, parallel to axis NO', qv in fig. 1.13. Then, by rotating the first metallic ring around the armilla's axis *NS*, we shall install this ring in the plane of the meridian, which will happen when the shadow from the external edge of the ring shall cover the inner part of the ring exactly. Finally, having fixed the plane of the first ring, we must make the second ring orthogonal to the first, so that its inner part would be covered by the shadow cast by its outer part. Fig. 1.13 demonstrates that the second ring shall end up right in the plane of the ecliptic as a result of these manipulations (more precisely, it shall be parallel to the ecliptic plane). As we have fixed both rings in the necessary position, the perpendicular P_1P_2 to the second ring shall also be fixed, thus marking the pair of polar points P_1 and P_2 on the first ring. We shall therefore be able to measure the angle P_1ON with sufficient precision; it is obviously equal to the angle between the ecliptic and the equator.

We have described the method that was allegedly used by the ancient astronomers. Despite the geometrical simplicity of the idea, one can clearly see the numerous complications that introduce different errata into the numeric value of the measured angle. In particular, the observer must know the following parameters:

a) the direction of axis *ON*, which is parallel to the axis of the Earth;

b) the day of solstice;

c) the moment of midday in this point of Earth surface.

R. Newton made the following justified remark: "The primary shortcoming of this instrument is that one has to be rather quick when one uses it, since the rotation of the Earth has a negative effect on the precision of the device" ([614], page 150). Indeed, in

fig. 1.13 we can see that the rotation of the Earth begins to turn the instrument around axis $O'N$, which renders the above considerations invalid.

Strictly speaking, the points O (the centre of the armilla) and O' (the centre of the Earth), as seen in fig. 1.13, are different points. The distance between the two is equal to the radius of the Earth. However, this discrepancy is negligibly small for the above calculations. Therefore, we can assume that $O = O'$ insofar as these measurements are concerned, as shown in fig. 1.13.

Let us come back to the measurements of the ecliptic coordinates with the aid of the armilla.

After the correct installation of the device as described above, it is tuned to the ecliptic coordinate system for a short time, namely, the plane of the second ring E_1E_2 is parallel to the ecliptic plane. Points E_1 and E_2 shall correspond to the solstice points. Both rings are presumed graded. Therefore, we can unambiguously define points R_1 and R_2 on the second ring, which shall correspond to the equinoxes. They divide arcs E_1 and E_2 in two halves. Points R_1 and R_2 are omitted from fig. 1.13 so as not to make the illustration too cluttered. Thus, what we have on the second ring is a scale with a fixed initial reference point (R_1, for instance, which is the vernal equinox point). We can thus measure ecliptic longitudes and latitudes of points on the celestial sphere, such as stars.

However, let us reiterate that the daily rotation of the Earth quickly sets off the precision of the instrument. Therefore, one needs a precise chronometer in order to compensate for the rotation of the Earth and tune the instrument. This is how the modern measurement instruments are constructed – the rotation of the Earth is compensated by the automatic tracking system.

In order to facilitate the measurements of celestial objects' ecliptic coordinates, a third ring is usually added to the armillary sphere – a rotating one. The axis of its rotation can, it turn, slide along the second ring, which is positioned in the plane of the ecliptic. We shall omit these details, since they are of little importance to us.

Let us now consider the third instrument, or the quadrant (see fig. 1.14). This instrument is based on the meridian circle and has a sharp pointer at its centre, which is perpendicular to the plane of this circle.

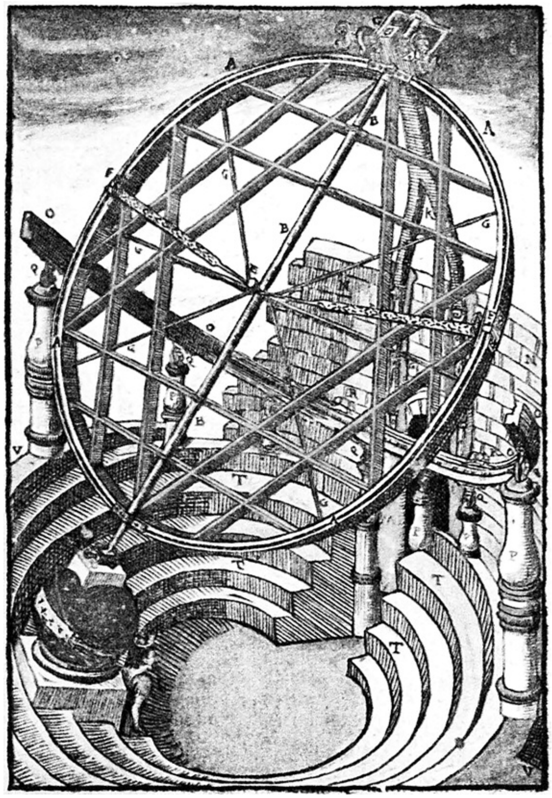


Fig. 1.12. "The large armillary sphere of Tycho Brahe for measuring the angular distances between luminaries" (from ***Mechanics Rejuvenated by Astronomy***, a work of Tycho Brahe. Windsbeck, 1598. Taken from [926], page 62.

The shadow from the pointer falls over the lower (northern) side of the meridian circle and can move within the confines of one quarter of the circumference. Therefore, in order to measure the height of the Sun it suffices to grade one quarter of the ring. The quadrant is therefore a plate of some sort with a graded quarter of a circle installed in the plane of the meridian. The height of the Sun above the horizon at midday is indicated by the shadow of the pointer that falls over the scale.

In fig. 1.15 we see the astronomical quadrant from a mediaeval book of 1542 by Oronce Fine ([1029], page 19).

Fig. 1.16 shows us a small quadrant with a radius of 39 centimetres, which belonged to Tycho Brahe ([1029], page 26).

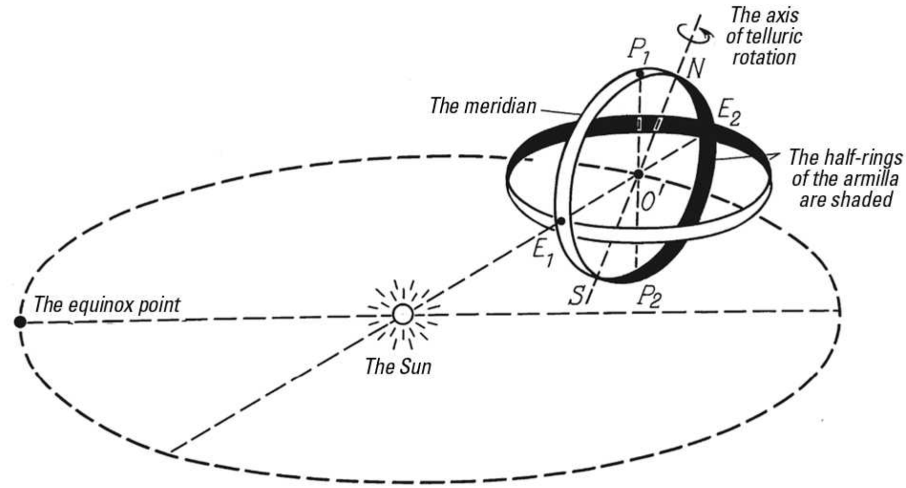


Fig. 1.13. A scheme of utilising the armilla for the measurement of the angle between the equator and the ecliptic, for instance.

In fig. 1.17 we see Tycho Brahe's sextant with a radius of 1.55 metres, and in fig. 1.18 – another sextant of Tycho Brahe of the same size ([1029], page 26).

In fig. 1.19 we see the astronomer Hevelius portrayed performing measurements with the aid of the sextant ([1029], page 67).

The fourth instrument is the astrolabe (see fig. 1.20). The mediaeval astrolabe is a round metallic plate with a diameter of some 50 centimetres, with a graded ring mounted rigidly on one of its edges. At the centre of the ring there is a mobile plank with visors mounted on an axis perpendicular to the centre of the circle. The instrument can be suspended vertically; there is a special loop at the edge of the plate that serves this purpose. The plane of the vertically suspended circle could be directed at a celestial body, likewise the rotating mobile plank. This is how the body's height above the horizon was measured. Apart from that, after the measurement of the height of the Sun at midday, one could also measure the observation latitude. The precision of such measurements must have been rather low due to the primitive nature of the method used. It is believed that the instrument in question could measure the observation point lat-

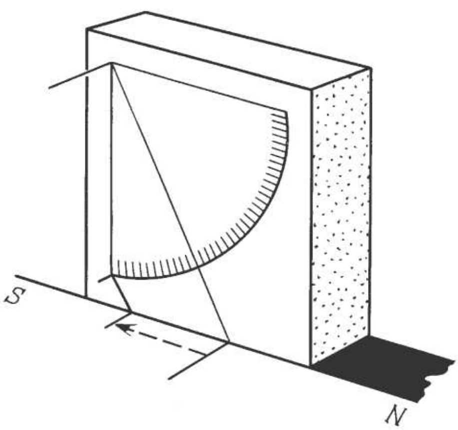


Fig. 1.14. A scheme of the quadrant.

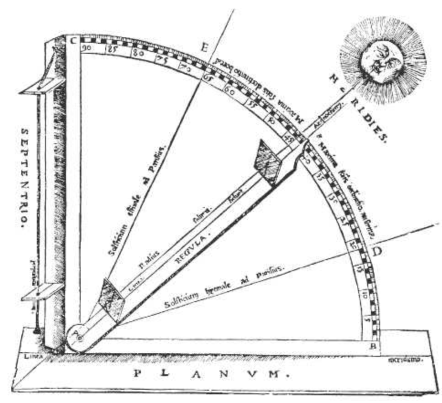


Fig. 1.15. An astronomical quadrant from a mediaeval book by Finney. Taken from [1029], page 19.

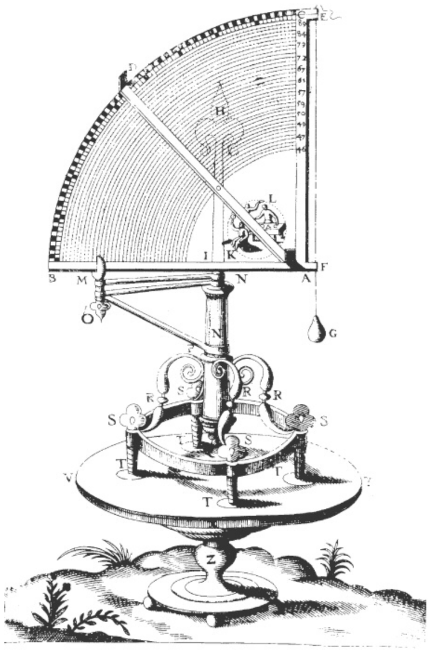


Fig. 1.16. A small quadrant of Tycho Brahe (1598). Taken from [1029], page 26.

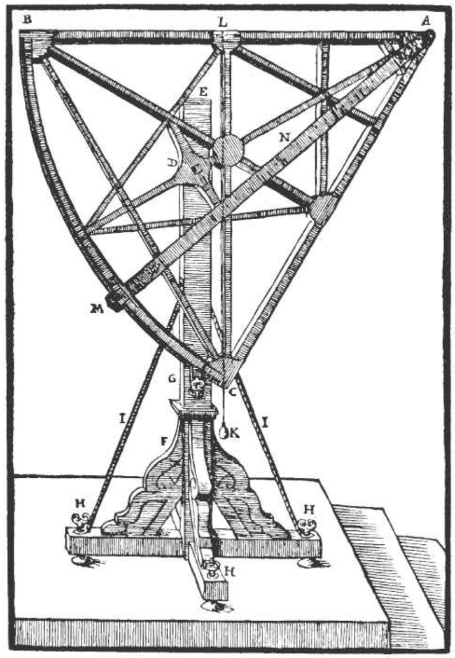


Fig. 1.17. The sextant of Tycho Brahe (1598). Taken from [1029], page 26.

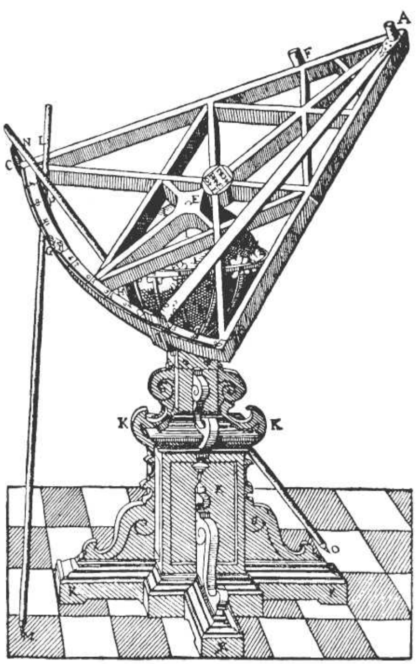


Fig. 1.18. Another sextant that belonged to Tycho Brahe (1598). Taken from [1029], page 26.

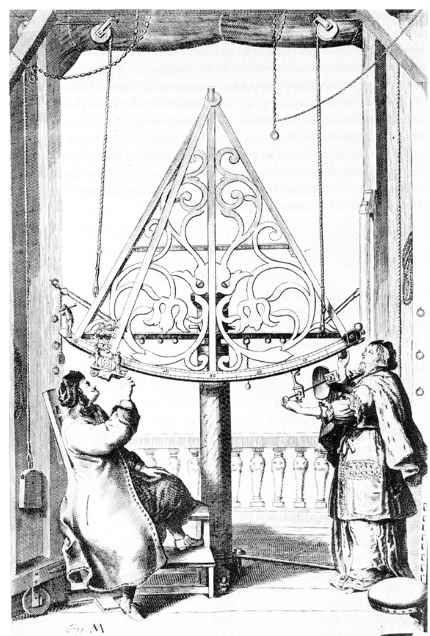


Fig. 1.19. The astronomer Hevelius is using a large sextant for observations, assisted by his wife. Ancient engraving dating to 1673. Taken from [1029], page 67.

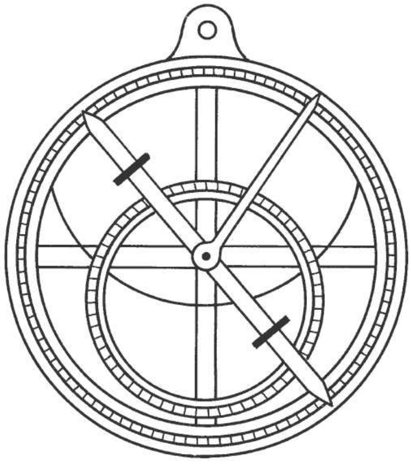


Fig. 1.20. A scheme of the astrolabe.

itude with the precision of several arc minutes ([614]).

In fig. 1.21 we see an old astrolabe of 1532 (Georg Hartmann, Nuremberg). We see the front and the reverse of the astrolabe.

In fig. 1.22 we reproduce an old picture of the famous mediaeval astronomical instrument known as "the Turkish tool", or "torquetum" ("turquetum"). Specialists in the history of science tell us the following: "The 'torquetum' (or 'turketum'), whose name can be translated as 'the Turkish tool', was characteristic for the mediaeval European astronomy, and embodies the intellectual heritage of Ptolemy as well as the Islamic tradition… The torquetum was used for measuring all three types of astronomical coordinates and the conversions between different types of coordinates, which was stipulated by the Ptolemaic planetary theory" ([1029], page 17). The instrument shown in fig. 1.22 belonged to Petrus Apianus (1497-1552). We are therefore told that the mediaeval Turks "revived" the Ptolemaic theory of measurements, manufacturing the necessary tools after many years of oblivion – namely, fifteen hundred years later than the "ancient" Ptolemy.

As we are beginning to realise, the mediaeval Ottoman turketum was a contemporary of the Ptolemaic devices. These instruments were made in the XV-XVII century.

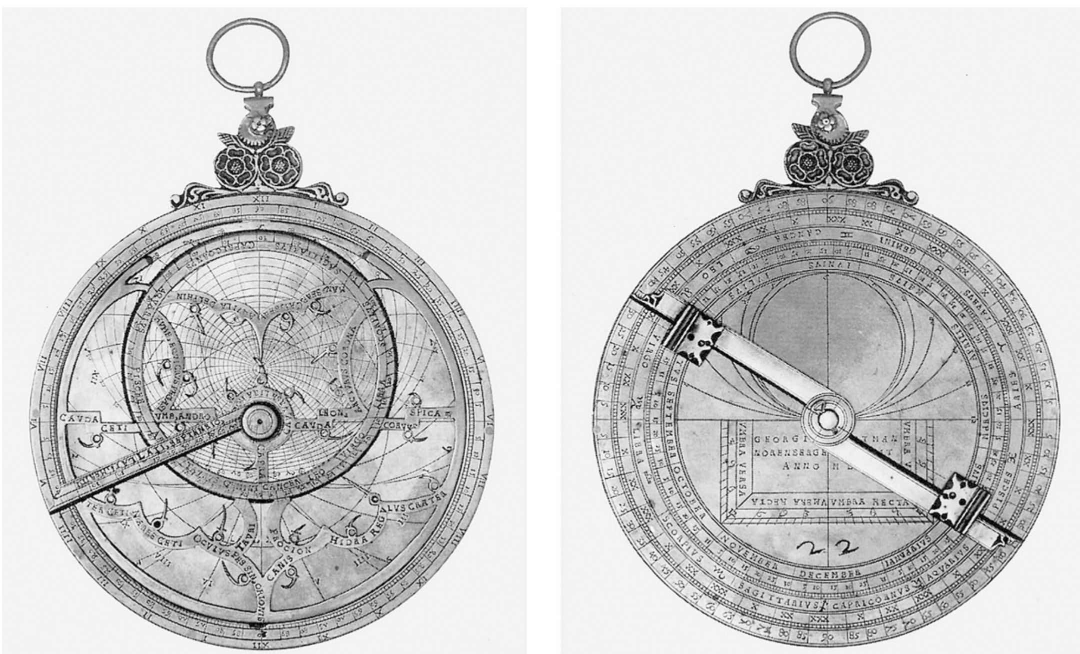


Fig. 1.21. The astrolabe of Georg Hartmann from Nuremberg. We see both the front and the reverse sides of the instrument. Taken from [1029], page 15.

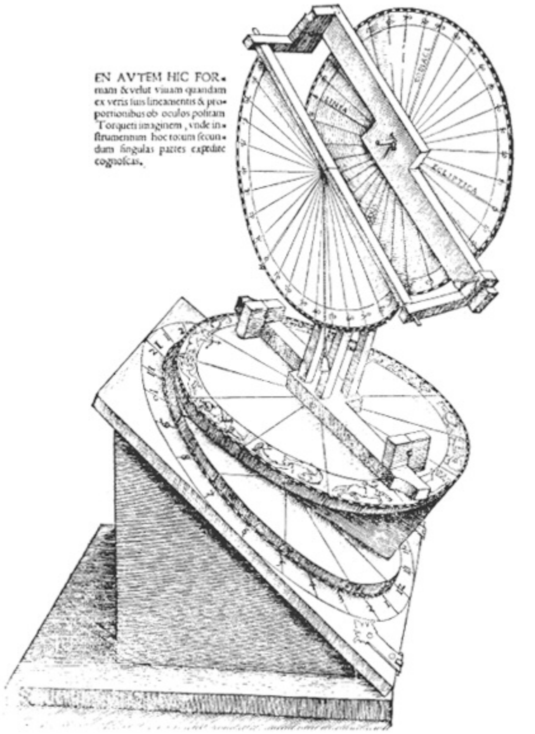


Fig. 1.22. A mediaeval instrument known as turketum ("Turkish"). Designed for estimating several types of celestial objects' coordinates. It was also utilised in Ptolemaic planetary theory (Werner, 1533). Taken from [1029], page 18.

7. TIMEKEEPING AND TIMEKEEPING DEVICES IN MEDIAEVAL ASTRONOMICAL OBSERVATIONS

As we have pointed out earlier, in order to conduct precise astronomical observations, the ancient astronomers needed a chronometer with a minute hand or some equivalent thereof. It would be expedient to recollect the history of mediaeval timekeeping in this respect in order to compare the precision of mediaeval timekeeping devices to the relative precision of the coordinates included in mediaeval star catalogues, the Almagest catalogue in particular.

In general, it has to be mentioned that the very concept of time was rather idiosyncratic in the Middle Ages. The analysis of the ancient documents demonstrates that this concept differed from the modern to a great extent. In particular, time was often considered "anthropomorphic" before the invention of the clock – more specifically, its character and speed would depend on the nature of events. As we already reported in CHRON1, "before the XIII-XIV century timekeeping devices were a rarity and a luxury. Sometimes even the scientists would lack them. The Englishman Valcherius … regretted the fact that the precision of his lunar eclipse observations of 1091 was impaired by the absence of a chronometer" ([1461], page 68). Timekeeping devices of low precision were introduced in the Middle Ages: "the usual timekeeping devices in mediaeval Europe were sundials … hourglasses and clepsydrae. However, sundials were only useful for sunny days, and clepsydrae remained a rarity" ([217], page 94).

In fig. 1.23 we see the astronomical rings of the XVII-XVIII century, which were used for telling the time by the Sun in particular. The method of their use is shown in an old drawing that we reproduce in fig. 1.24. In fig. 1.25 one sees an old hourglass.

Mass production of clepsydrae falls over the XIII-XIV century. Clepsydrae were used by Tycho Brahe (1546-1601). He used them in order to measure planetary velocities ([954], page 36). In the Middle Ages "the clepsydra was a popular device, its low precision notwithstanding. In order to make them more precise, the constructors of the clepsydrae had to take into account the fact that the water doesn't leave the vessel at a constant speed – the latter depends on the pressure, that is to say, the greater the level of water in a vessel, the greater the pressure. The constructors of the clepsydrae improved the construction somewhat, making it more complex, so that the clock wouldn't slow down as the vessel on top emptied… However, clepsydrae had the tolerance of around 10-20 minutes per day, and even the best scientists of the epoch couldn't think of a way to make them substantially more precise" ([288], pages 32-33).

At the end of the IX century candles were used widely for timekeeping purposes. For instance, Alfred, King of England, took candles of different length along on his voyages and ordered to light them one after another ([217], page 94). This method of timekeeping was still used in the XIII-XIV century – in the reign of Charles V and other monarchs of the epoch. Timekeeping candles were known as "the fire clock".

Fig. 1.23. An instrument of the XVII-XVIII century that was used for solar timekeeping, among other things. Taken from [1029], page 21.

Many countries preserved this timekeeping method for a long time. "The Japanese, for example, used timekeeping devices consisting of various incense sticks leaning one against another as recently as 200 years ago. One could 'smell' the hour by their aroma, as it were. The Europeans used 'fire clocks' as well – they were candles with special markings" ([954], page 37). We can see that all these "ancient" timekeeping methods were used relatively recently; one must think, they were invented not so very long ago.

"Fire clocks" were used in China for a long time as well. Special kinds of powdered wood were made into a paste, which would then be rolled into sticks of various shapes – spirals and so on. Occasionally, metal balls were tied to these sticks in certain places. As the stick burned, they would fall into a vase and make a sound. "The precision of 'fire clocks' also left much to be desired – apart from the difficulty of making perfectly uniform sticks and candles, the speed of their combustion always depended on the atmospheric conditions (wind, fresh air supply etc)" ([288], pages 30-31).

The hourglass was another popular timekeeping device of the Middle Ages. "The precision of the hourglass depends on the stability of the sand flow. In order to make the hourglass more precise, one needs to use sand of as uniform a texture as possible, soft, dry and forming no lumps inside the vessel. Mediaeval craftsmen of the XIII achieved this by boiling the mixture of sand and marble dust with wine and lemon juice, skimming it, then drying and repeating the process nine times over. All of these measures notwithstanding, the hourglass remained a timekeeping instrument of low precision" ([288], page 30). In the XII century, the secular rulers of Mons who wanted to begin a process at a given time had to consult with the ecclesiastic authorities about the time of day" ([1037], pages 117-118).

Nowadays it is believed that the first mention of a mechanical chronometer dates from the end of the VI century A.D. ([797]). Then the devices disappear for a long time to resurface already during the Renaissance. According to the specialists in the history of sciences, "the first mechanical clock was made by the ingenuous and curious Italian craftsmen in the XIII century" ([954], page 38). The principle of their construction is simple enough – a rope with a weight on its end is woven onto a horizontal shaft. The weight pulls the unwinding rope, which rotates the shaft. If we are to attach a hand to the shaft, it will tell the time. Despite the simplicity of the principle, its practical realisation required a stable slow rate of shaft rotation. This purpose was achieved by means of using numerous wheels, which transferred the rotation of the shaft to the hand, and clever regulators of all kinds, installed to make the shaft rotation rate more or less uniform. "Mechanical clocks were constructions of formidable size. Enormous clockwork mechanisms were installed on the towers of cathedrals and palaces" ([954], page 38). A flywheel from Tycho Brahe's clock had 1200 notches and a diameter of 91 centimetres" ([288], page 35). "The wheels of some clocks weighed hundreds of kilos. Due to the large weight of their parts and substantial friction, wheel-based mechanical clocks required lubrication and constant maintenance. The daily tolerance rate of such clocks equalled several minutes" ([288], page 35).

"It was only in the XV century that the spring replaced the shaft and rope in clockwork mechanisms.

The weight of clocks was reduced dramatically. Craftsmen of the early XVI century mastered the construction of mobile spring-based clocks that weighed 3 or 4 kilos. They were the rather heavy ancestor of the modern mechanical watch" ([954], page 39).

The invention of the clock with a minute hand must have been followed by the compilation of a more or less precise longitudinal star catalogue. What is the significance of the minute hand? The matter is that the celestial sphere and all the objects seen upon it rotates at the speed of one degree per 4 minutes; therefore, a star passes 15 arc minutes per minute of time. Star catalogues contain coordinates of stars indicated with arc minutes – therefore, in order to make the catalogue precision tolerance equal circa 15 arc minutes, one needs to be able to track the time interval of one minute on a timekeeping device. The tolerance of circa 10 minutes (as in the Almagest, for instance) requires the ability of measuring 40-second intervals reliably. Higher precision of a catalogue requires a higher precision of timekeeping devices. Of course, the observers could use their intuition for the measurement of short time intervals (one minute and less), but this would introduce subjective errata into the catalogue.

Thus, the ancient astronomers who claimed their catalogues to have a tolerance of 10' needed to have a chronometer with a minute hand or some analogue thereof at their disposal. However, Ptolemy, who gives us a detailed description of all the instruments required for the measurements of stellar coordinates (the armillary sphere etc) doesn't mention any chronometers and altogether refrains from the discussion of the timekeeping problem and its direct relation to the observations of the celestial sphere, which is in a constant motion.

The hypothesis that chronometers with a minute hand could exist in the II century A.D. contradicts Scaligerian information about the history of timekeeping devices, as we shall shortly see.

Also, the above implies that if we really discover some sort of catalogue whose precision tolerance equals 10 arc minutes as declared by the author of the Almagest, and this tolerance is verified by statistical research, we shall have a good reason to assume that the compiler of the catalogue was using a clock with a minute hand or some equivalent of it.

Fig. 1.24. The astronomical rings of Gemma Frisius. "A portable equatorial instrument that could be used at any latitude … for solar timekeeping, as well as many other approximated astronomical observations (Apianus, 1539). Taken from [1029], page 21.

According to the history of timekeeping, the hour hand was introduced into the mechanism of a clepsydra in the XIII century A.D. ([544], Volume 4, page 267) or even later. The timekeeping devices in question had no pendulum, and were therefore of low precision. It was only in the XIV century A.D. that different cities of mediaeval Europe got tower clockwork mechanisms (Milan in 1306 and Padua in 1344). It is reported that they were built by a certain Dondi Horologiu. Clocks with springs moved by a weight were only brought into existence in the XV century. Walther was the first to use them for astro-

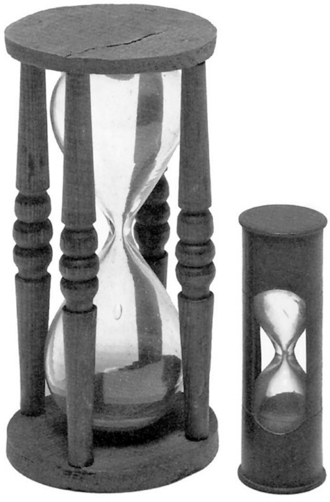


Fig. 1.25. Ancient hourglasses. Cambridge, Whipple Museum. Taken from [1029], page 31.

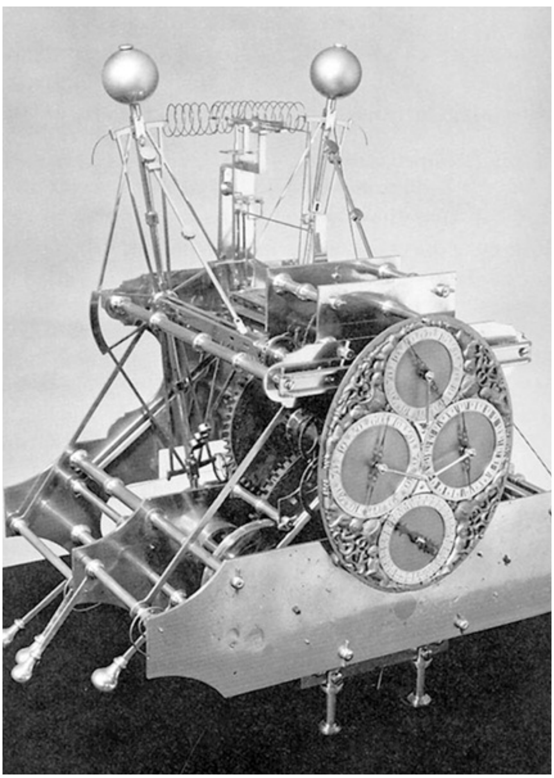


Fig. 1.26. The first chronometer created by John Harrison in 1735. The height of the instrument is 408 millimetres. Taken from [1029], page 140.

nomical observations, followed by many others up to Tycho Brahe ([544], Volume 4, pages 267-268).

According to the history of sciences, "various mechanical clocks only had the hour hand initially. In the middle of the XVI century the minute hand was introduced, and the second hand's invention took place 200 years later" ([954], page 39). The invention of the mechanical clock's minute hand is usually dated to 1550 A.D. ([288], page 36). It is believed that the first chronometer was only constructed in the XVIII (1785, by John Harrison). Harrison lived around 1683-1776 ([1029], page 139). Harrison's chronometer is a complex enough instrument; it can be seen in fig. 1.26.

The modern mechanical clock, including the pendulum, was invented by Huygens in 1657 ([797]). In 1561 the Kassel observatory was built – a unique construction, since it was the first to embody the principle of rotating roof (a device used in most modern observatories). After the death of Regiomontan and Walther, Landgrave Wilhelm IV of Hessen-Kassel (1532-1592), the creator of said observatory, conducted extensive observations of immobile stars (see Chapter 11 below). In general, "the primary purpose of the Kassel observatory was the compilation of a star catalogue … The most remarkable innovation was the clock used for timekeeping and measurements involving the motion of the celestial sphere. The construction of a clock whose precision was adequate for this purpose owes its successful implementation to the mechanical genius of Bürgi [1522-1632 – Auth.], and, in particular, to his discovery that the clock can be regulated by the pendulum – apparently, he hadn't made any attempts of making this invention public, and so the pendulum was reinvented before it could be acknowledged by everyone [in re the discovery of Galileo and Huygens – Auth.]. By 1586, the positions of 121 stars were registered with the greatest care, but the complete catalogue, which was supposed to contain over 1000 stars, has never been finished" ([65], page 118).

The activity of Tycho Brahe, who worked in the same epoch, soon completely outshone the efforts of the Kassel observatory. It is curious enough that the scientists of the Kassel observatory already used refraction compensation to counteract the errata introduced by the refraction of sunlight in the atmosphere ([65], page 118).

It was only in the time of Huygens that the clock became an integral part of many astronomical instruments: "One of the inventions made by Huygens completely revolutionized the art of precise astronomical observation. Huygens attached the pendulum to the clock that was set in motion by weights, in such a manner that the clock maintained the pendulum in motion, which, in turn, regulated the motion of the clockwork.

It is likely that Galileo planned to unite the pendulum and the clockwork mechanism towards the end of his life, but we have no proof that he ever managed to make this idea come alive.

This invention has given us the opportunity to make precise observations, and, noting the gap between two stars crossing the meridian, deduce their angle distance to the west or the east, knowing the speed of the celestial sphere's motion.

Picard was the first to appreciate the importance of this invention for astronomy, introducing correct timekeeping in the newly built Paris Observatory" ([65], page 177).

CHAPTER 2

A preliminary analysis of the Almagest star catalogue

1. THE CATALOGUE STRUCTURE

The Almagest star catalogue comprises its seventh and eighth books. We were using the canonical edition of the Almagest star catalogue for our research, as published by Peters and Knobel ([1339]), as well as the two complete editions of the Almagest translated by R. Catesby Taliaferro ([1355]) and Toomer ([1358]). The first Russian translation of the Almagest came out in 1998 ([704]).

Before we give our characteristic to the catalogue, it would be expedient to remind the reader of a few concepts used in literature on the history of astronomy.

The Almagest star catalogue was compiled in the ecliptic coordinate system. As we mentioned earlier, in most of its editions and copies stellar latitudes are rendered to the epoch of circa 60 B.C. In other words, the initial longitudinal reference point was recalculated by someone to correspond to the position of the sun in relation to the stars as they would appear to the observer from the middle of the I century A.D. on the day of vernal equinox.

Stellar longitudes as indicated in the Almagest catalogue relate to the so-called even Zodiac as counted off the vernal equinox point of a given epoch. Let us explain that the even or "monthly" Zodiac is a mere division of the ecliptic into twelve equal parts as stipulated by the epoch of observation. It has to be emphasised that (strictly speaking) the even Zodiac is defined by the observable solar trajectory on the celestial sphere and not the zodiacal constellations per se. The ecliptic arc covered by the Sun during the first month of "march" (not the calendar march, but the month that begins on the day of vernal equinox) is commonly referred to as "Aries". The next "equinoctial month of April" is when the Sun passes through the constellation of Taurus of the even Zodiac. Next come Gemini, Cancer, Leo, Virgo, Libra, Scorpio, Sagittarius, Capricorn, Aquarius, and, finally, Pisces. This is how the annual ecliptic circle ends. Thus, the even Zodiac can be regarded as a simple way of dividing the ecliptic into 12 equal 30-degree parts starting with the vernal equinox point for a given epoch. Precession makes this initial point of reference shift along the ecliptic at the rate of circa 1 degree per seventy years. These shifts are significant, but relatively small as compared to the thirty-degree span of a whole sign. Therefore, the even Zodiac, once chosen for its approximate correspondence to the constellations of the Zodiac, retains this correspondence to this day. In other words, if the Sun is in Aries (or March, according to the even Zodiac), it shall be near the zodiacal constellation of Aries. The reverse is possible as well – namely, that the boundaries

Table 2.1. Signs of the even Zodiac corresponding to 30-degree arcs (or longitudinal intervals) as counted from spring equinox point of the current epoch.

Latin name of a sign	*Abbreviated Latin name*	*Longitudinal interval*
Aries	Ari	0 – 30
Taurus	Tau	30 – 60
Gemini	Gem	60 – 90
Cancer	Can	90 – 120
Leo	Leo	120 – 150
Virgo	Vir	150 – 180
Libra	Lib	180 – 210
Scorpius (Scorpio)	Sco	210 – 240
Sagittarius	Sag	240 – 270
Capricornus (Capricorn)	Cap	270 – 300
Aquarius	Aqu	300 – 330
Pisces	Pis	330 – 360

of zodiacal constellations were once defined in such a manner as to correspond to the even Zodiac – the visible solar route, or the ecliptic, divided into twelve even parts.

In table 2.1 we cite the complete list of signs (or arcs) that comprise the even Zodiac. All of them are counted off the variable vernal equinox point.

Stellar longitudes were transcribed with the aid of these arc signs (or month signs) in the Middle Ages. For instance, "15°20' in Taurus" stood for 45°20' as counted off the current vernal equinox point (or some other point chosen as referential by the authors of a given catalogue for reasons of their own). It has to be stated that the equinox point didn't always serve the referential purpose in the old catalogues. Let us consider another example: "15°20' in Libra" would mean 225°20' as counted off the point of reference. See table 2.1. This is how the longitudes are transcribed in the Almagest catalogue.

Ecliptic latitudes of stars in the Almagest are indicated according to a simpler principle – namely, they are counted off the ecliptic that corresponds to the latitudinal zero degree and up to the ecliptic pole corresponding to the 90th latitudinal degree. The Alpha of Ursa Minor, for example, has the latitude of +66°0' in the Almagest. The "+" or "–" here refer to the respective location of the star in the Northern or Southern Hemisphere.

As we have pointed out already, zodiacal signs do not correspond to zodiacal constellations, which is why the stars that pertain to a single zodiacal constellation can wind up in different zodiacal signs.

The canonical version of the Almagest catalogue contained in the work of Peters and Knobel ([1339]) is presented as a table that consists of six columns.

The first column contains the index number of a given star in the Almagest. This numeration was devised by the astronomer Bailey. Surviving manuscripts of the Almagest contain no numerical indexation. Bailey was a famous commentator and researcher of the Almagest. According to Bailey, the sum total of stars listed in the Almagest equals 1028. There are minute discrepancies between the estimates of different researchers, one of the reasons for their very existence being the fact that some stars were listed twice in the Almagest (see [1339] for more details).

The stars are grouped by constellation in the Almagest; each of the constellations has a name. The Almagest lists 48 constellations all in all; we shall cite the actual list below. Some constellations have annexes referred to as "*Informata*" – auxiliary stars that weren't included in the main list of stars comprising a given constellation. The Latin term "*informata*" translates as "shapeless" or "amorphous" ("*informis*", "*informitas*" etc). In other words, the main list apparently contains the stars that the ancient astronomer believed to form the "skeleton" of the constellation, whereas the stars listed as "*informata*" provide the "backgrouond" of sorts. It is possible that the compiler of the catalogue believed the stars of the *informata* category to be of a lesser importance than the "main" stars. One must bear in mind that the ancient astronomy was closely linked to astrology, where the visual outline of a constellation was of paramount importance. Some of the Almagest constellations have no *informata* whatsoever. A full list of constellations can be found below, in table 2.2.

The second column of the table in [1339] contains a verbal description of the star in question and the part it plays in the general shape of a given constellation. Such descriptions are often rather vague. For instance, the Alpha of Ursa Minor is referred to as "the star on

the tip of the tail" in the Almagest. In the canonical version of the Almagest ([1339]) verbal descriptions of stars were taken from the Latin edition of 1528 translated by Trebizond. They were verified by the Greek edition. It is believed that the initial language of the Almagest was Greek. See Chapter 11 for more details concerning the history of the Almagest's manuscripts and first editions.

The modern names of the stars can be found in the third column of the table in [1339]. Actually, this column contains the names of the Almagest stars identified on the star chart of today. Said identifications are the result of much labour performed by the scientists whose research involved the Almagest. What complicates such identifications is the rather whimsical nature of the verbal descriptions in question. Moreover, the very figures of constellations could vary from one astronomical school to another over the course of years. Therefore, the identification of the Almagest stars as some of the stars that we know today is anything but self-implied. Obviously enough, this is the very first problem to solve before we can proceed to analyse other characteristics of the catalogue.

An enormous body of work was conducted by the XVII-XIX century astronomers in order to identify the Almagest stars. The final version can be found in [1339]. We shall forthwith refer to it as "canonical". The same source ([1339]) contains the table of discrepancies between the opinions of different specialists in re the identification of a given star. This table contains several such identifications of Almagest stars.

The fourth column contains the ecliptic longitude of a star as related to the arc (or sign) of the even Zodiac that the longitude value in question falls over.

The fifth column contains the star's ecliptic latitude.

The sixth column corresponds to the "brightness" (or size) of the star.

2. THE ANALYSIS OF THE DISTRIBUTION OF RELIABLY AND POORLY IDENTIFIABLE STARS IN THE ALMAGEST

The book ([1339]) contains a table entitled "Identification Discrepancies", which deals with the different identifications of certain Almagest stars made by the following famed researchers: Peters, Bailey, Schjellerup, Pierce and Manitius. Different identifications of certain Almagest stars on the celestial sphere of our epoch suggested by said astronomers are also indicated.

We have partially processed this enormous body of material. First of all, it is very useful to indicate the location of the constellations mentioned in Ptolemy's star catalogue geometrically. Let us use a modern map that specifies constellation boundaries for this end. In fig. 2.1. these boundaries are represented as uninterrupted zigzagged lines. This is an approximated representation, of course, since the ancient constellations had no rigidly defined borders. However, it suffices for a rough estimate, therefore we can assume that fig. 2.1 gives us a correct qualitative representation of how the Almagest constellations are positioned on the celestial sphere.

Let us compare this illustration to the star chart (with drawn constellations) from the first editions of the Almagest – in Greek and in Latin, dating from the XVI century A.D. In fig. 2.2 we see a star chart of the Northern hemisphere drawn by Albrecht Dürer, and in fig. 2.3 – the chart of the Southern hemisphere by the same artist. Dürer created these maps in 1515 (see [544], Volume 4, pages 204-205; also [90], pages 8-9). Dürer's map of the Northern Hemisphere was included in the 1527 edition of the Almagest ([90], page 8). Dürer's star chart of the Southern Hemisphere saw another edition in 1527, slightly altered (we reproduce it in fig. 2.4).

In figs. 2.5 and 2.6 we see two more star charts included in another edition of the Almagest (dating from 1551). It is very peculiar that although the "ancient" Ptolemy is supposed to have lived in the II century A.D., some of the constellation figures are dressed in mediaeval attire ([543], pages 216-217).

In figs. 2.7 and 2.8 we also reproduce the maps of the Northern and Southern hemisphere compiled in accordance with the Almagest by the astronomer Bode in the XVIII century.

Dürer's star chart does not contain any precise borders of Almagest constellations. The matter is that Dürer merely drew the symbolic figures of zodiacal constellations – Hercules, Pegasus etc. Nevertheless, a comparison with the modern star chart demonstrates that modern constellation borders are in good

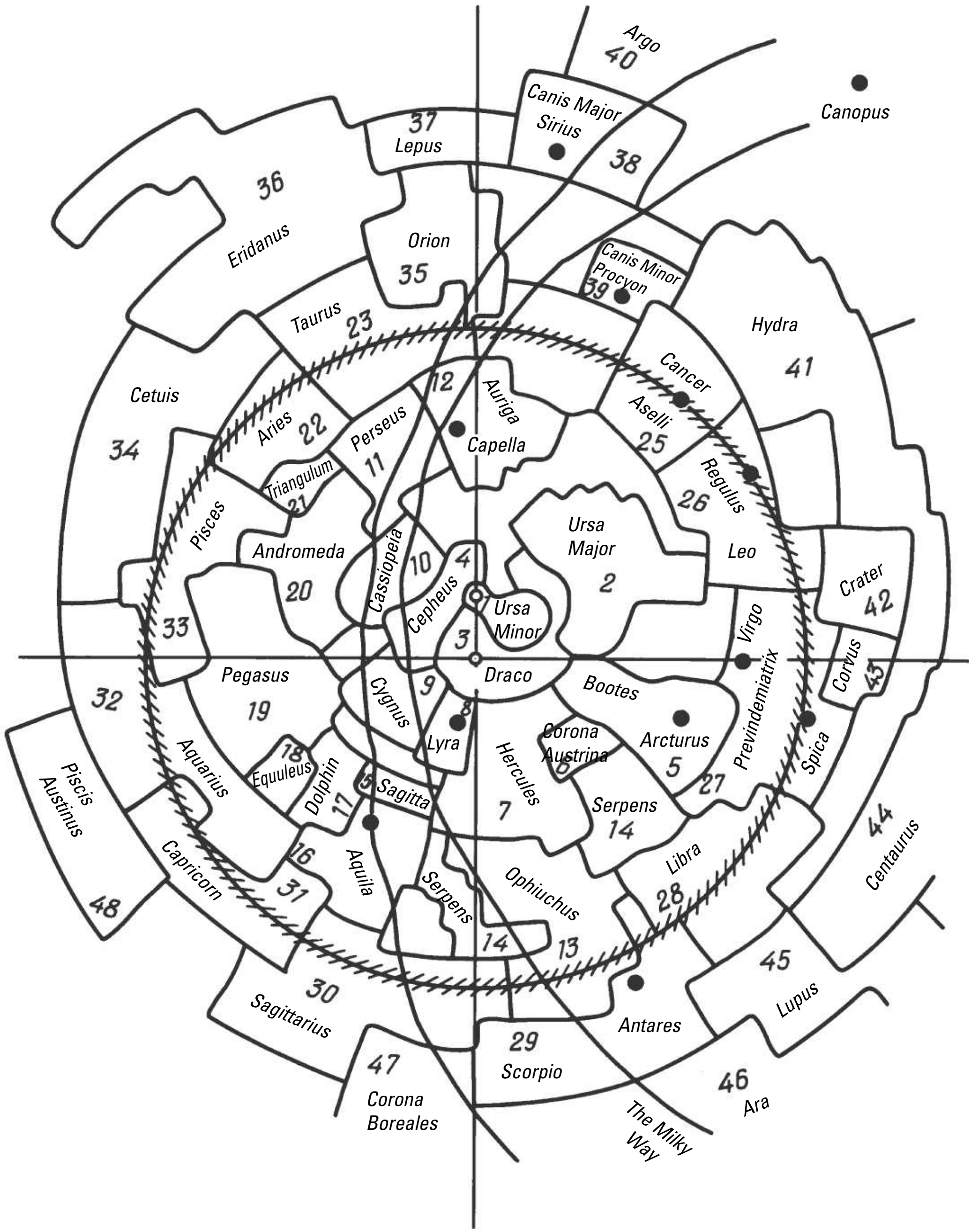


Fig. 2.1. Modern boundaries of the constellations mentioned by Ptolemy in the Almagest.

Fig. 2.2. Star chart of the Northern Hemisphere drawn by Albrecht Dürer in 1515. Taken from [544], Volume 4, page 204. See also [90], page 8.

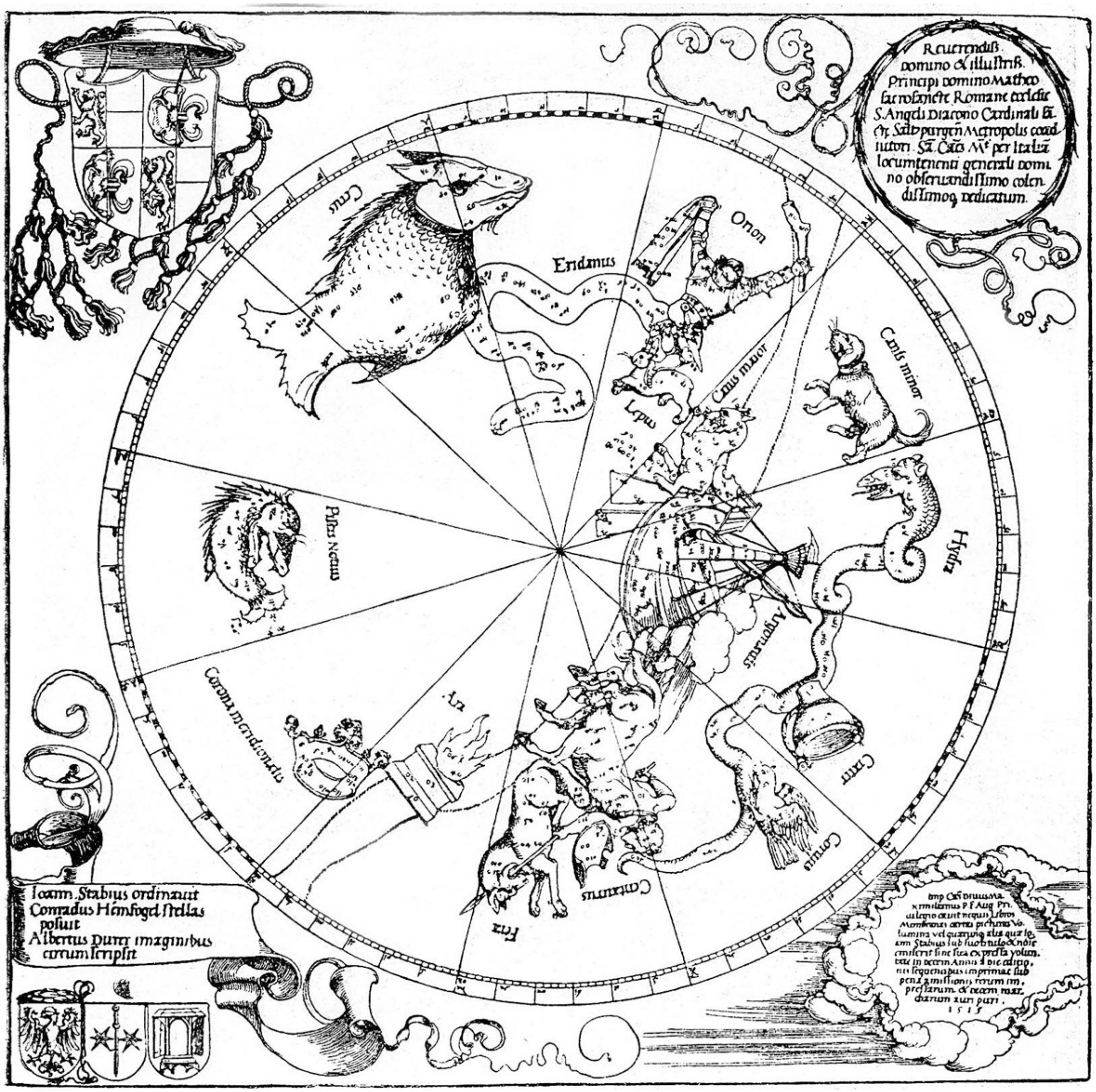


Fig. 2.3. Star chart of the Southern Hemisphere drawn by Albrecht Dürer in 1515. Taken from [544], Volume 4, page 105.

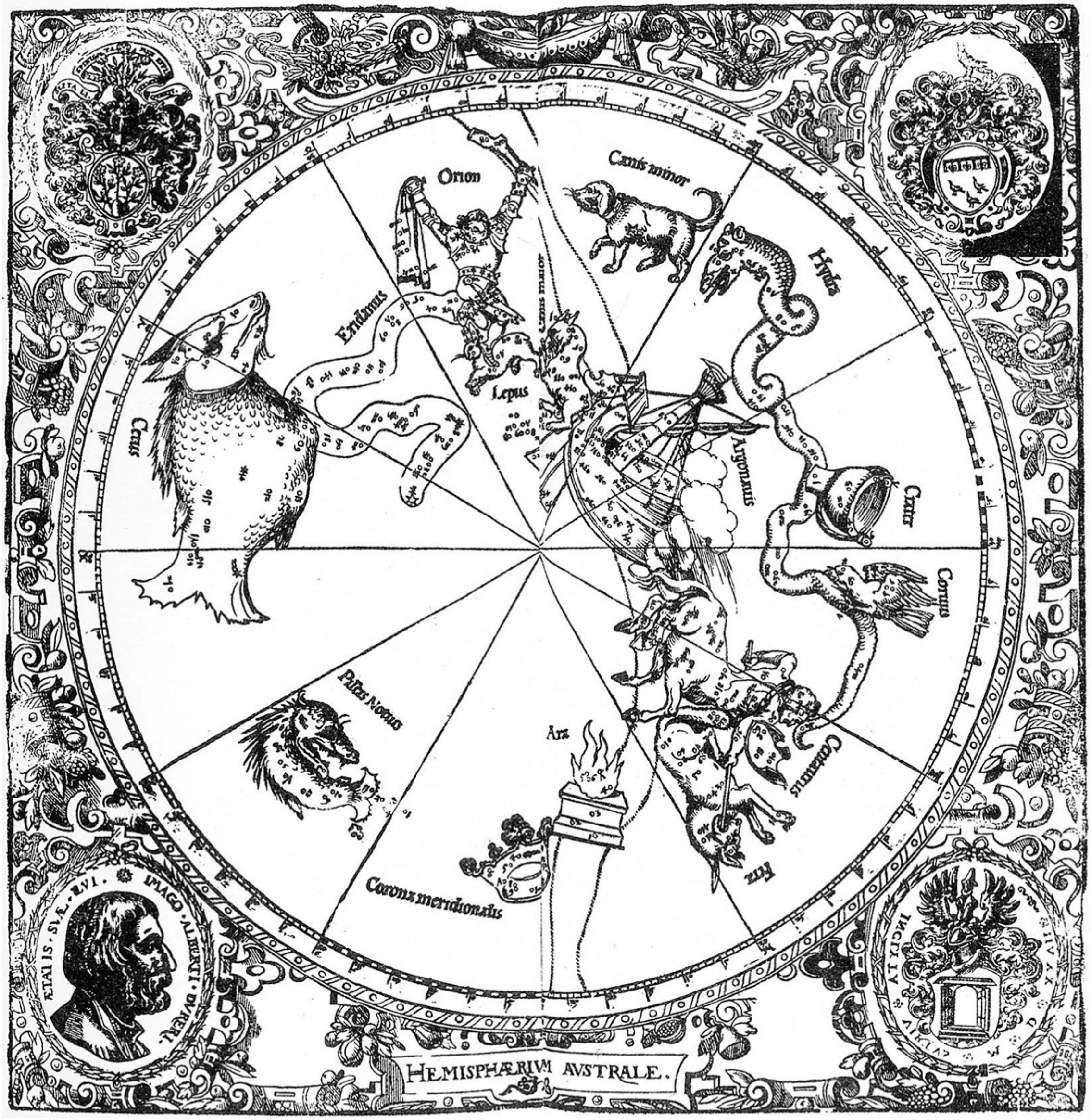


Fig. 2.4. Dürer's star chart of the Southern Hemisphere, published once again in 1527 – this time somewhat altered. According to the commentators, "the decorative framing was added subsequently, and includes a portrait of the painter" ([90], page 9). There was nothing of the kind in the map of 1515. Taken from [90], page 9.

correspondence with the figures from Dürer's star charts in the Almagest.

In fig. 2.9 we reproduce a page of the star catalogue from an edition of the Almagest that dates from 1551. In fig. 2.10 one sees a page from the Greek version of the Almagest that was written in the IX century ([1374], page 143). A page from another version of the Almagest (in Latin, dating from the XIII-XIV century) is reproduced in fig. 2.11. In fig. 2.12 we see a page from George Trebisond's Latin version of the Almagest (circa 1481 A.D. – see [1374]). It is most likely that all these editions hail from the XVI-XVII century the earliest. We shall consider the issue of their dating in the chapters that follow. Let us return to the Almagest star catalogue.

In fig. 2.1 the shaded circle represents the ecliptic. The wide vertical stripe curved leftwards is the Milky Way. Of course, its borders are defined rather approximately and demonstrate the distribution of the densest parts of the Milky Way. Inside the regions that correspond to constellations we have indicated their names and numbers in accordance with the Almagest. For example, Ursa Minor is the first constellation listed in the Almagest, Ursa Major is the second, Draco is the third etc.

The Almagest contains twelve named stars, or stars that possess proper names. Verbal description of such stars always contains the formula "*vocatur*" (which translates as "named"). Thus, "*vocatur Arcturus*" stands for "star named Arcturus". All these stars are represented as large black dots in fig. 2.1. They are as follows: Arcturus, Previndemiatrix, Spica, Regulus, Acelli, Sirius, Procyon, Lyra = Vega, Cappella, Aquila, Canopus and Antares. We see that most of them happen to be located to the right of the Milky Way, on Milky Way or in its immediate vicinity. Canopus is de facto located outside of the star chart, since the star in question lies very far in the South.

Let us enquire about the order of constellations in Ptolemy's list. This purpose stipulates the compilation of a new chart where every constellation is replaced by the symbolic representation of its centre (a light circle, qv in fig. 2.13). Obviously enough, constellation centres can only be defined approximately, but no great precision is needed here, since we are only interested in a rough qualitative picture. Let us then draw arrows to link adjacent constellations together. We shall end up with a curve whose motion from one constellation to another reflects the order of constellations in Ptolemy's list. It is remarkable that the resulting curve attains the shape of a spiral that begins with Ursa Minor and goes clockwise, up to the very end of the Almagest list. This is precisely where the celestial pole is, qv in fig. 2.1. Right next to it, in Draco, we have the North Pole as well as the pole of the ecliptic. Let us follow the order of Ptolemy's motion across the celestial sphere as he lists the constellations (see the curve in fig. 2.13).

The curve will obviously be divisible into several parts. First Ptolemy lists all the constellations numbered 1-8, namely, the constellations of Ursa Minor, Ursa Major, Draco, Cepheus, Boötes, Corona Borealis, Hercules and Lyra. They are located in the area bordered by the zodiacal belt on the right and the Milky Way on the left.

Then the curve proceeds across the Milky Way. Ptolemy lists all the constellations included in the Milky Way or overlapping with the latter to a great enough extent. Those are Cygnus, Cassiopeia, Perseus, Auriga, Ophiuchus, Serpens and Sagitta (numbered 9-15).

Next Ptolemy deals with the area that lays to the left of the Milky Way (its left borderline is defined by the Zodiacal belt, qv in fig. 2.13). He consecutively lists the constellations of Aquila, Delphinus, Equuleus, Pegasus, Andromeda and Triangulum (numbered 16-21).

After that the curve moves on to the Zodiac and goes around the centre of the star chart. Ptolemy provides a list of all twelve Zodiacal constellations, namely, Aries, Taurus, Gemini, Cancer, Leo, Virgo, Libra, Scorpio, Sagittarius, Capricorn, Aquarius and Pisces (numbered 22-23).

Finally, Ptolemy leaves the Northern Hemisphere, crosses the Zodiacal Belt and moves towards the Southern Hemisphere, listing the constellations in the following order: Cetus, Orion, Eridanus, Lepus, Canis Major, Canis Minor, Vela, Hydra, Crater, Corvus, Centaurus, Lupus, Ara, Corona Australis and Piscis Austrinus (numbered 34-48). This is where the Almagest star catalogue ends.

Thus, Ptolemy's order of constellations is based on a very obvious principle – the self-implied division of the star chart into several regions.

We shall refrain from delving deep into the reasons why the author of the catalogue chose to list the con-

Fig. 2.5. Star chart of the Northern Hemisphere from a 1551 edition of the Almagest. Some of the constellation figures are wearing mediaeval clothes, no less. Taken from [543], inset between pages 216 and 217.

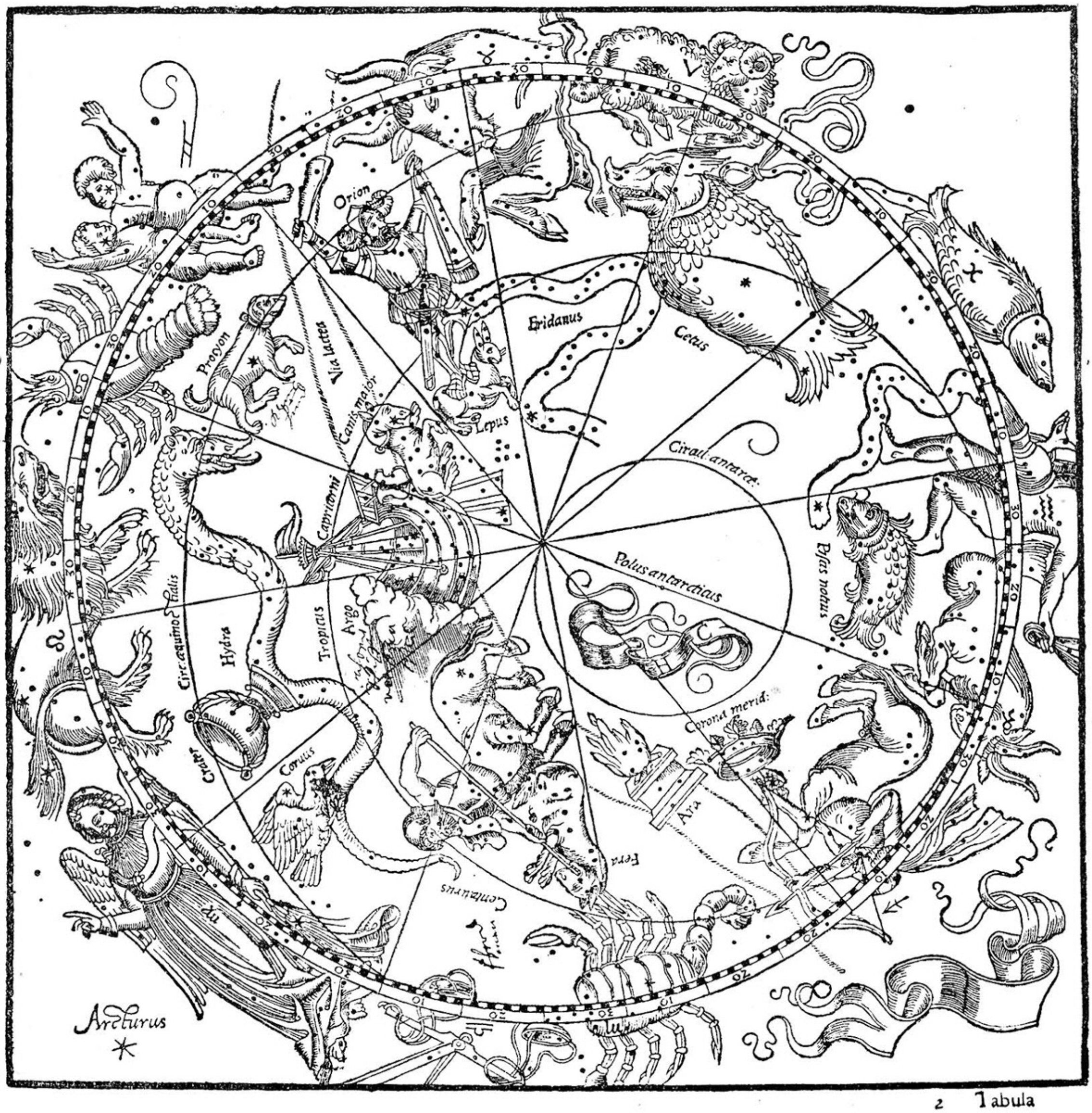


Fig. 2.6. Star chart of the Southern Hemisphere from a 1551 edition of the Almagest. The constellation of Orion, for instance, looks like a mediaeval knight. Taken from [543], inset between pages 216 and 217.

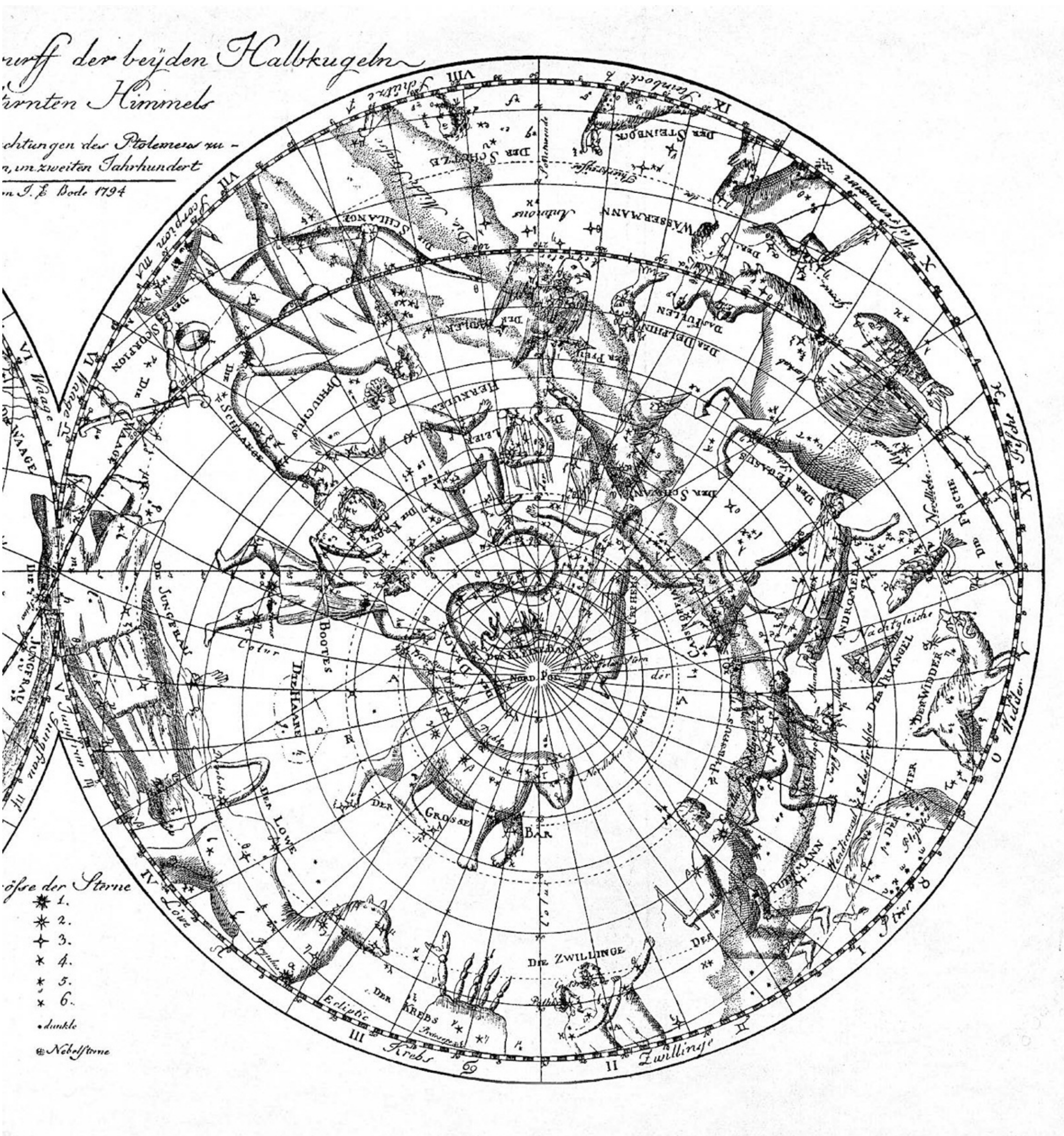


Fig. 2.7. Star chart of the Northern Hemisphere, compiled by the astronomer Bode in the XVIII century according to Ptolemy's Almagest. Published in ***Claudius Ptolemaeus Beobachtung und Beschreibung der Gestirne*** by J. E. Bode, 1795, page 238. Taken from [544], Volume 4, inset between pages 184 and 185.

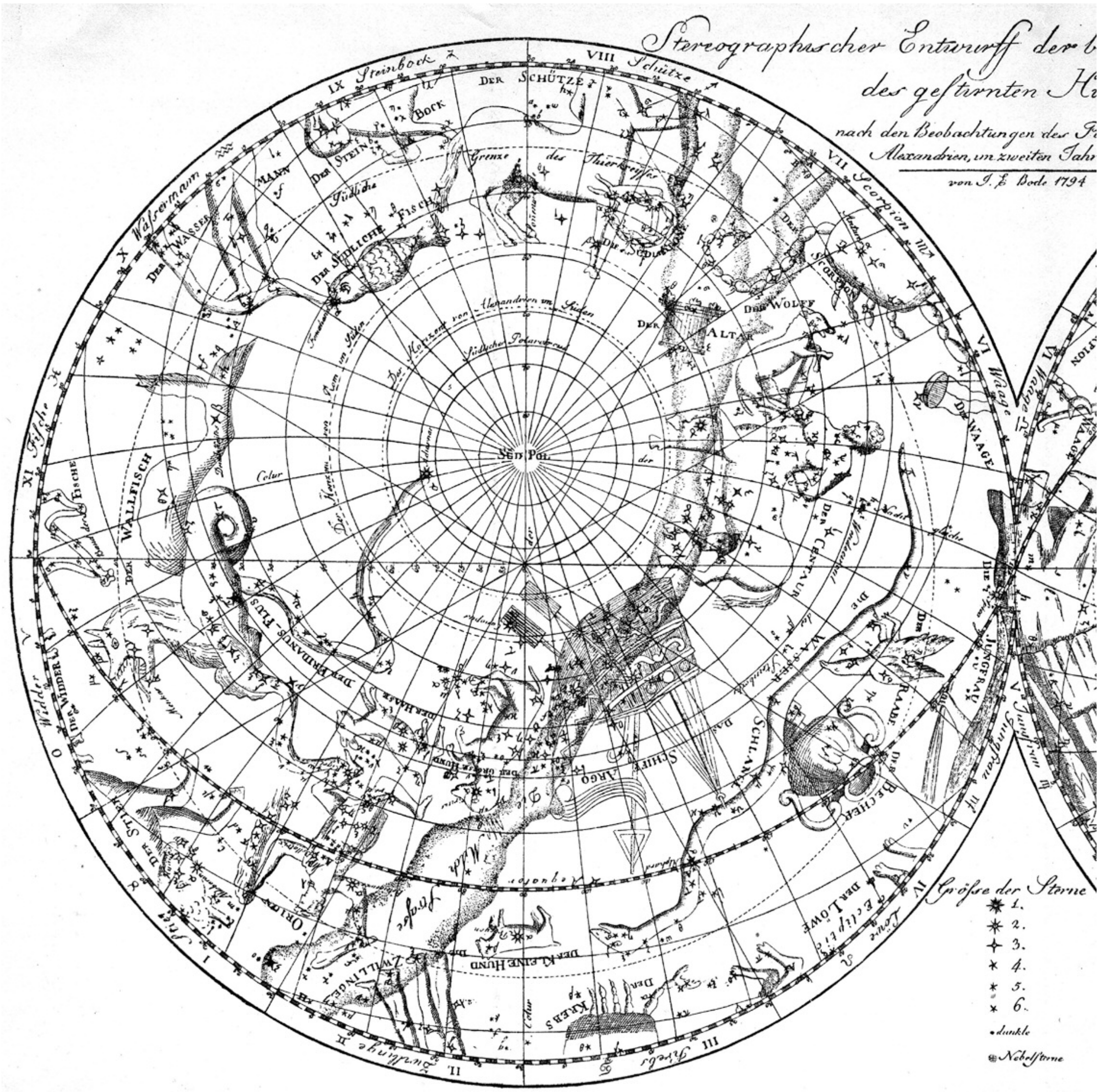
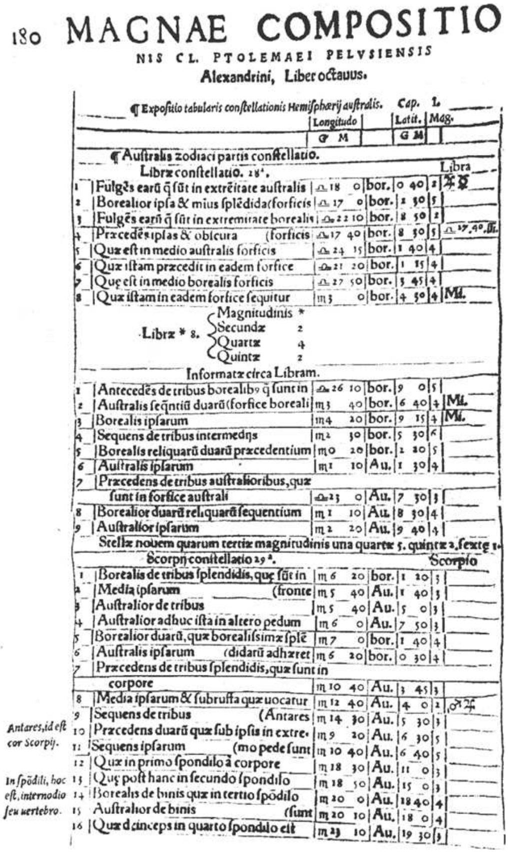


Fig. 2.8. Star chart of the Southern Hemisphere, compiled by the astronomer Bode in the XVIII century according to Ptolemy's Almagest. Published in ***Claudius Ptolemaeus Beobachtung und Beschreibung der Gestirne*** by J. E. Bode, 1795, page 238. Taken from [544], Volume 4, inset between pages 184 and 185.



180 MAGNAE COMPOSITIO
NIS CL. PTOLEMAEI PELVSIENSIS
Alexandrini, Liber octauus.

¶ Expositio tabularis constellationis Hemisphærij australis. Cap. I.

		Longitudo G	M	Latit.	G M	Mag.	
	¶ Australis zodiaci partis constellatio.						
	Libræ constellatio. 28ª.						Libra
1	Fulgēs earū q̄ sūt in extrēitate australis	♎ 18	0	bor.	0 40	2	♃ ☿
2	Borealior ipsa & mius splēdida (forficis	♎ 17	0	bor.	2 30	5	
3	Fulgēs earū q̄ sūt in extremitate borealis	♎ 22	10	bor.	8 30	2	
4	Præcedēs ipsas & obscura (forficis	♎ 17	40	bor.	8 30	5	♎ 17.40. Bo.
5	Quæ est in medio australis forficis	♎ 24	15	bor.	1 40	4	
6	Quæ istam præcedit in eadem forfice	♎ 21	20	bor.	1 15	4	
7	Quę est in medio borealis forficis	♎ 27	50	bor.	3 45	4	
8	Quæ istam in eadem forfice sequitur	♏ 3	0	bor.	4 30	4	Mi.

Libræ * 8. { Magnitudinis * / Secundæ 2 / Quartæ 4 / Quintæ 2 }

	Informatæ circa Libram.						
1	Antecedēs de tribus borealib9 q̄ sunt in	♎ 26	10	bor.	9 0	5	
2	Australis seq̄ntiū duarū (forfice boreali	♏ 3	40	bor.	6 40	4	Mi.
3	Borealis ipsarum	♏ 4	20	bor.	9 15	4	Mi.
4	Sequens de tribus intermedijs	♏ 2	30	bor.	5 30	6	
5	Borealis reliquarū duarū præcedentium	♏ 0	20	bor.	2 20	5	
6	Australis ipsarum	♏ 1	10	Au.	1 30	4	
7	Præcedens de tribus australioribus, quæ sunt in forfice australi	♎ 23	0	Au.	7 30	3	
8	Borealior duarū reliquarū sequentium	♏ 1	10	Au.	8 30	4	
9	Australior ipsarum	♏ 2	20	Au.	9 40	4	

Stellæ nouem quarum tertiæ magnitudinis una quartæ 5. quintæ 2. sextę 1.

	Scorpij constellatio 29ª.						Scorpio
1	Borealis de tribus splendidis, quę sūt in	♏ 6	20	bor.	1 20	3	
2	Media ipsarum (fronte	♏ 5	40	Au.	1 40	3	
3	Australior de tribus	♏ 5	40	Au.	5 0	3	
4	Australior adhuc ista in altero pedum	♏ 6	0	Au.	7 50	3	
5	Borealior duarū, quæ borealissimæ splē	♏ 7	0	bor.	1 40	4	
6	Australis ipsarum (didarū adhæret	♏ 6	20	bor.	0 30	4	
7	Præcedens de tribus splendidis, quæ sunt in corpore	♏ 10	40	Au.	3 45	3	
8	Media ipsarum & subruffa quæ uocatur	♏ 12	40	Au.	4 0	2	♂ ♃
9	Sequens de tribus (Antares	♏ 14	30	Au.	5 30	3	
10	Præcedens duarū quæ sub ipsis in extre-	♏ 9	20	Au.	6 30	5	
11	Sequens ipsarum (mo pede sunt	♏ 10	40	Au.	6 40	5	
12	Quæ in primo spondilo à corpore	♏ 18	30	Au.	11 0	3	
13	Quę post hanc in secundo spondilo	♏ 18	50	Au.	15 0	3	
14	Borealis de binis quæ in tertio spōdilo	♏ 20	0	Au.	18 40	4	
15	Australior de binis (sunt	♏ 20	10	Au.	18 0	4	
16	Quæ deinceps in quarto spondilo est	♏ 23	10	Au.	19 30	3	

Antares, id est cor Scorpij.

In spōdili, hoc est, internodio seu uertebro.

Fig. 2.9. Fragment of the star catalogue from a 1551 edition of the Almagest.

stellations in this particular way – let us simply point out the naturally occurring regions that the Almagest star atlas can be divided into (see fig. 2.14).

Region *M* is the Milky Way, which divides the sky into two parts. Then we have region *A*, which is the part of the celestial sphere that lays to the right of the Milky Way and goes up unto the very Zodiacal belt, comprising the right part of the latter. Region A contains a part that consists of Zodiacal constellations exclusively; we shall indicate it as "*Zod A*".

Next we have region *B* – the part of the sky to the left of the Milky Way that reaches up to the zodiacal belt and includes some of the latter's left part – thus, the part of this region that consists of Zodiacal constellations exclusively shall be labelled "*Zod B*". Finally, region *D* is the southernmost part of the celestial sphere to the left of the Milky Way, which lays to the right of the Zodiac in fig. 2.14.

As we shall see below, such division of the Almagest star atlas is anything but random and possesses several remarkable properties that permit a deeper understanding of the statistical characteristics of the Almagest star catalogue.

Let us point out the specific and rather interesting manner of constellation listing characteristic for the Almagest. For instance, the compiler of the catalogue would be perfectly justified to list the events moving in a spiral and shifting between parts *A* and *B*, making circular periodic movements around the pole. However, Ptolemy opts for a completely different approach. First he lists the constellations that lay to the right of region *M*, then the constellations of that actual region, followed by the ones found on its left, the Zodiacal constellations, and, finally, the southern stars. Ptolemy must have had some motives of his own that have led to this particular choice; the nature of his motivation is however of little importance to us. We are interested in the result – namely, the actual method of listing stars as chosen above.

It is very important (and nowhere near obvious) that the division of the Almagest star atlas into regions is very closely linked to different "precision characteristics" of said regions.

As we have already pointed out, specialists adhere to different opinions in re the identification of some Almagest stars. The table reproduced in [1339] contains a list of all discrepancies between the opinions of the five most prominent researchers and commentators of the Almagest. But what does the very fact of there being such discrepancies between the identifications of different Almagest stars tell us?

It tells us that the coordinates of the star with several different identifications were not measured with sufficient precision by Ptolemy. Since the stars of the first and second magnitude constitute a minority, the rest can only be identified by the coordinates indicated in the Almagest. They need to be compared to the coordinates of the modern stars in order to find a fitting equivalent on the celestial sphere. Obviously enough, this method, which is often the only one available for the identification of an unnamed and relatively dim star, works well only in cases where Ptolemy had measured the coordinates of the star in

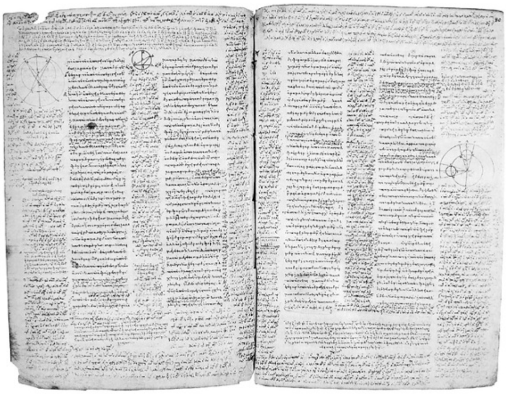


Fig. 2.10. Greek version of Ptolemy's Almagest, allegedly manufactured in the IX century. Taken from [1374], page 143.

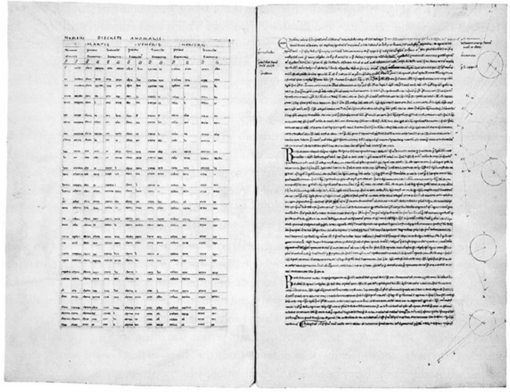


Fig. 2.11. Latin version of the Almagest, allegedly dating from the XIII-XIV century. Taken from [1374], page 146.

question with sufficient precision. If there were serious errata in the process of taking measurements, there may be several identification options.

The situation becomes particularly complex when the star under study is part of an agglomeration of stars whose brightness is more or less uniform. There may be many different identifications of a single Almagest star; the choice between them shall be hard to make.

This is the reason for the controversial identification of certain Almagest stars.

The "final" version of identifications as cited in the catalogue of Peters and Knobel ([1339]) may have a greater or a lesser priority as compared to the opinions of other researchers. We shall so far refrain from discussing this issue in greater detail, since it is quite beyond the scope of our research. One finds the scientific accuracy of Peters and Knobel most laudable – they have diligently listed all the discrepancies between different identifications in a single table. We shall use this table in order to perform a few simple yet extremely useful calculations. They give us the opportunity to make important corollaries concerning the precision of Ptolemy's stellar coordinate measurements for different parts of the celestial sphere.

The above permits the acceptance of the hypothesis that if some Almagest star cannot be identified unequivocally, its coordinates in the Almagest must contain errors. We can refer to such stars as "dubiously identifiable" or "poorly identifiable". Thus, if we consider some fixed constellation, the proportion of "dubiously identifiable" stars that it contains shall demonstrate how many stars in this constellation weren't measured with sufficient precision. The calculation of these proportions makes it possible to estimate just how precisely Ptolemy measured the coordinates of the star in question.

Thus, we can select the percentage of dubiously identifiable stars as the precision criterion of Ptolemy's observations for a given constellation. In other words, we need to calculate the value of $(X/T) \times 100\%$ for every constellation, where T stands for the sum total of stars and X – for the number of dubiously

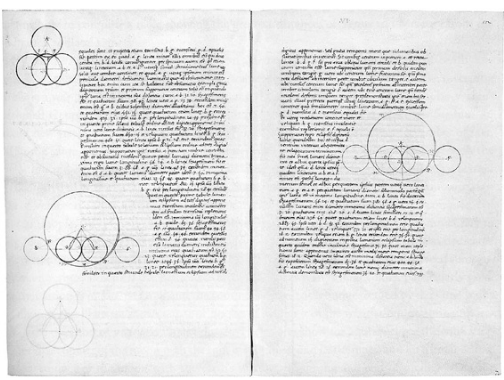


Fig. 2.12. Another Latin version of the Almagest, translated into Latin by George Trebizond around 1481. Taken from [1374], page 147.

identifiable stars contained by the constellation in question.

The end result shall accumulate a great deal of preliminary work conducted by the previous researchers of the Almagest. There was a great deal of such research, therefore one has every reason to assume that the average result of their activities may be considered to represent a more or less veracious picture unaffected by the subjectivism of certain specialists.

We have researched this issue and compiled our results into table 2.2. This table contains eight columns.

In the *first column* one finds the number of the constellation as listed in the Almagest.

The *second column* contains a reference to the part of the celestial sphere where the Almagest constellation in question is located. Let us remind the reader that there are seven such regions (we dubbed them *A, Zod A, B, Zod B, C, D* and *M*, qv in fig. 2.14).

The *third column* contains the name of the constellation (in Latin).

The *fourth column* informs us of the percentage of poorly identifiable stars in the "pure" constellation (sans *informata*).

In the *fifth column* the above percentage is calculated for all the stars in a constellation, the *informata* included.

The *sixth column* contains the percentage of poorly identifiable stars in the actual *informata*.

The *seventh column* contains the number of stars in a constellation.

The *eighth column* contains the number of stars in the respective *informata*. Columns 5 and 6 are blank in cases where there are no *informata* in a constellation, with zero in column 8. Table 2.2. lists all 48 constellations mentioned in the Almagest.

3.
SEVEN REGIONS OF THE ALMAGEST STAR ATLAS SIGNIFICANTLY DIFFER FROM EACH OTHER BY THE NUMBER OF RELIABLY IDENTIFIABLE STARS

Our analysis of table 2.2 implies the following:

Corollary 1. The seven regions that we mention in section 2 contain the following Almagest constellations:

- region *A*: constellations 1-8 and 24-29;

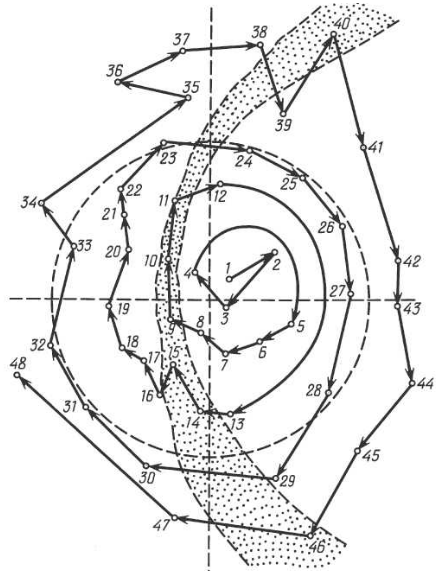


Fig. 2.13. An illustrative presentation of the order in which Ptolemy lists the constellations in the Almagest. Constellation centres are marked by white points in our scheme.

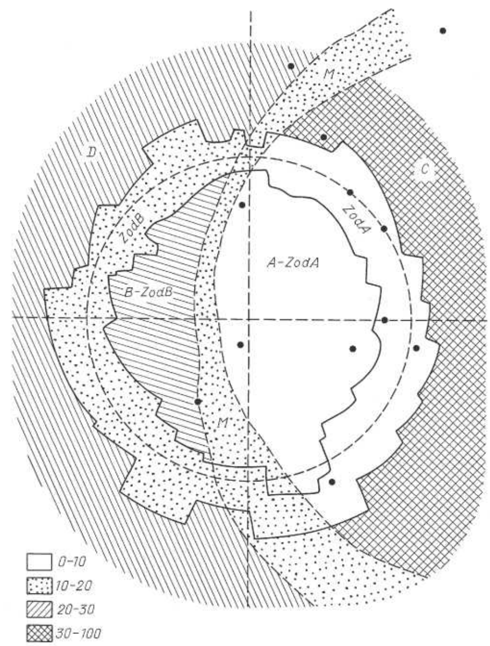


Fig. 2.14. Approximated scheme of the well-measured and badly-measured celestial areas from the Almagest. One can plainly see that only some of the areas are characterised by accurate measurements and therefore stand out. The white area was measured best in the Almagest.

Constellation number	*Almagest celestial area*	*Latin name of the constellation*	*Percentage of poorly-identifiable stars*			*Number of stars*	
			In a "pure" constellation	*In a constellation with informata*	*In the informata*	*In a "pure" constellation*	*In the informata*
1	A	Ursa Minor	0	0	0	7	1
2	A	Ursa Major	3.7	11.4	38	27	8
3	A	Draco	0	-	-	31	0
4	A	Cepheus	0	7.7	50	11	2
5	A	Bootes	27.3	26	0	22	2
6	A	Corona Boreal.	0	-	-	8	0
7	A	Hercules	10.3	10	0	29	1
8	A	Lyra	10		-	10	0
9	M	Cygnus	0	0	0	17	2
10	M	Cassiopeia	23	-	-	13	0
11	M	Perseus	3.8	6.9	33.3	26	3
12	A, M	Auriga	21.4	-	-	14	0
13	M	Ophiuchus	25	20.7	0	24	5
14	M	Serpens	0	-	-	18	0
15	M	Sagitta	0	-	-	5	0
16	B	Aquila	22.3	13.3	0	9	6
17	B	Delphinus	20	-	-	10	0
18	B	Equuleus	100	-	-	4	0
19	B	Pegasus	10	-	-	20	0
20	B	Andromeda	13	-	-	23	0
21	B	Triangulum	0	-	-	4	0
22	ZodB	Aries	0	0	0	13	5
23	ZodB	Taurus	21.2	25	36.4	33	11
24	ZodA	Gemini	5.6	20	57	18	7
25	ZodA	Cancer	0	23	75	9	4
26	ZodA	Leo	11.1	17.1	37.5	27	8
27	ZodA	Virgo	15.4	15.6	16.6	26	6
28	ZodA	Libra	0	23.5	44.4	8	9
29	ZodA	Scorpius	4.8	12.5	66.7	21	3
30	ZodB	Sagittarius	12.9	-	-	31	0
31	ZodB	Capricornus	3.6	-	-	28	0
32	ZodB	Aquarius	26.1	24.4	0	42	3
33	ZodB	Pisces	5.8	5.2	0	34	4
34	D	Cetus	22.7	-	-	22	0
35	D	Orion	8.9	-	-	38	0
36	D	Eridanus	26.4	-	-	34	0
37	D	Lepus	0	-	-	12	0
38	D	Canis Major	5.6	41.3	100	18	11
39	C	Canis Minor	0	-	-	2	0
40	C	Argo Navis	68.9	-	-	45	0
41	C	Hydra	16	22.2	100	25	2
42	C	Crater	57.1	-	-	7	0
43	C	Corvus	0	-	-	7	0
44	C	Centaurus	81	-	-	37	0
45	C	Lupus	100	-	-	19	0
46	C	Ara	100	-	-	7	0
47	D	Corona Austr.	100	-	-	13	0
48	D	Pisces Austr.	8.3	38.9	100	12	6

Table 2.2. Percentage of poorly identifiable stars in Almagest constellations.

- region *B*: constellations 16-23 and 30-33;
- region *Zod A*, which is part of region *A*: constellations 24-29;
- region *Zod B*, which is part of region *B*: constellations 22, 23, 30-33;
- region *D*: constellations 34-38, 47 and 48.
- region *C*: constellations 39-46;
- region *M*: constellations 9-15.

Corollary 2. The stars that constitute the *informata* in the Almagest were measured with comparatively low precision, with the exception of the following: 1 star in Ursa Minor, 1 star in Boötes, 1 star in Hercules, 2 stars in Cygnus, 5 stars in Ophiuchus, 6 stars in Aquila, 5 stars in Aries, 3 stars in Aquarius and 4 stars in Pisces, or 9 *informata* out of the total of 22.

The remaining thirteen *informata* were measured very badly. Indeed, we find 38% of poorly measured stars in the *informata* of Ursa Major, 50% in the *informata* of Cepheus, 33.3% in the *informata* of Perseus, 36.4% in the informata of Taurus, 57% in the informata of Gemini, 75% in the *informata* of Cancer, 37.5% in the *informata* of Leo, 16.6% in the *informata* of Virgo, 44.4% in the *informata* of Libra, 66.7% in the *informata* of Scorpio, and 100% in the *informata* of Canis Major, Hydra and Piscis Austrinus.

And so, there are lots of poorly measured stars in the *informata* of the Almagest in general. It would be apropos to voice the hypothesis (one that doesn't affect our further research in any way at all, as a matter of fact) that the stars collected in the *informata* did not constitute the primary "constellation pattern", which is why the measurement of their coordinates was performed with less precision – especially if the star in question was a dim one. Of course, if a bright star ended up among the *informata*, its coordinates could be measured with greater diligence. For instance, the famous Arcturus is part of the well-measured *informata* of Aquarius. However, table 2.2 shows us that in a typical situation the stars of the *informata* are measured with less precision than the stars of the "pure" constellation.

It would therefore strike one as natural to separate the *informata* from the main stars of the constellation for the time being. Actually, this is how it is done in the Almagest – the *informata* stars are gathered in a separate eponymous group. We shall consider the "pure" constellations alone.

This is the very reason why we introduced two separate columns in table 2.2 – one corresponds to the share of poorly identifiable stars in the "pure" constellation, and the other – to the main stars of the constellation with the *informata* added thereto. Our analysis of the fourth column demonstrates the picture to be completely different here. Apart from the "pure" constellations that were measured with relatively high accuracy, there are some whose stellar coordinates are less accurate.

For greater demonstrability, we have transcribed the numeric data from the fourth and the fifth column in the following manner:

Inside each of the constellations reproduced as a certain area confined within a zigzagging border there are two numbers. The fraction's nominator represents the share of poorly measured stars in the current "pure" constellation, sans the *informata*. The fraction's denominator contains the percentage of poorly measured stars together with the *informata*. There is no denominator if the constellation in question contains no *informata*; however, the fraction line is nonetheless present. The dotted line one sees in fig. 2.15 represents the Milky Way.

In order to facilitate the analysis of the above picture, let us count the average share of poorly identifiable stars separately (for each of the seven regions as described above). We shall add up the previously calculated rates for every constellation and divide the result by the number of constellations in the region. The result is represented in table 2.3.

Let us turn to fig. 2.16, where different regions are represented by different kinds of shading. They correspond to varying levels of observation quality. White colour stands for values between 0% and 5% of poorly measured stars. Dotted shading represents values falling between 6% and 10%, slanted shading – values between 21% and 30%, and, finally, black field stands for values between 31% and 100% of stars whose coordinates lack precision.

Thus, the darker a given area, the worse the quality of its measurement in the Almagest. We instantly notice the fact that many austral constellations in Area *C*, to the right of the Milky Way, are measured very poorly indeed – we see a lot of solid black shading here, qv in fig. 2.16. On the other hand, the constellations in Area *A* are measured a great deal better,

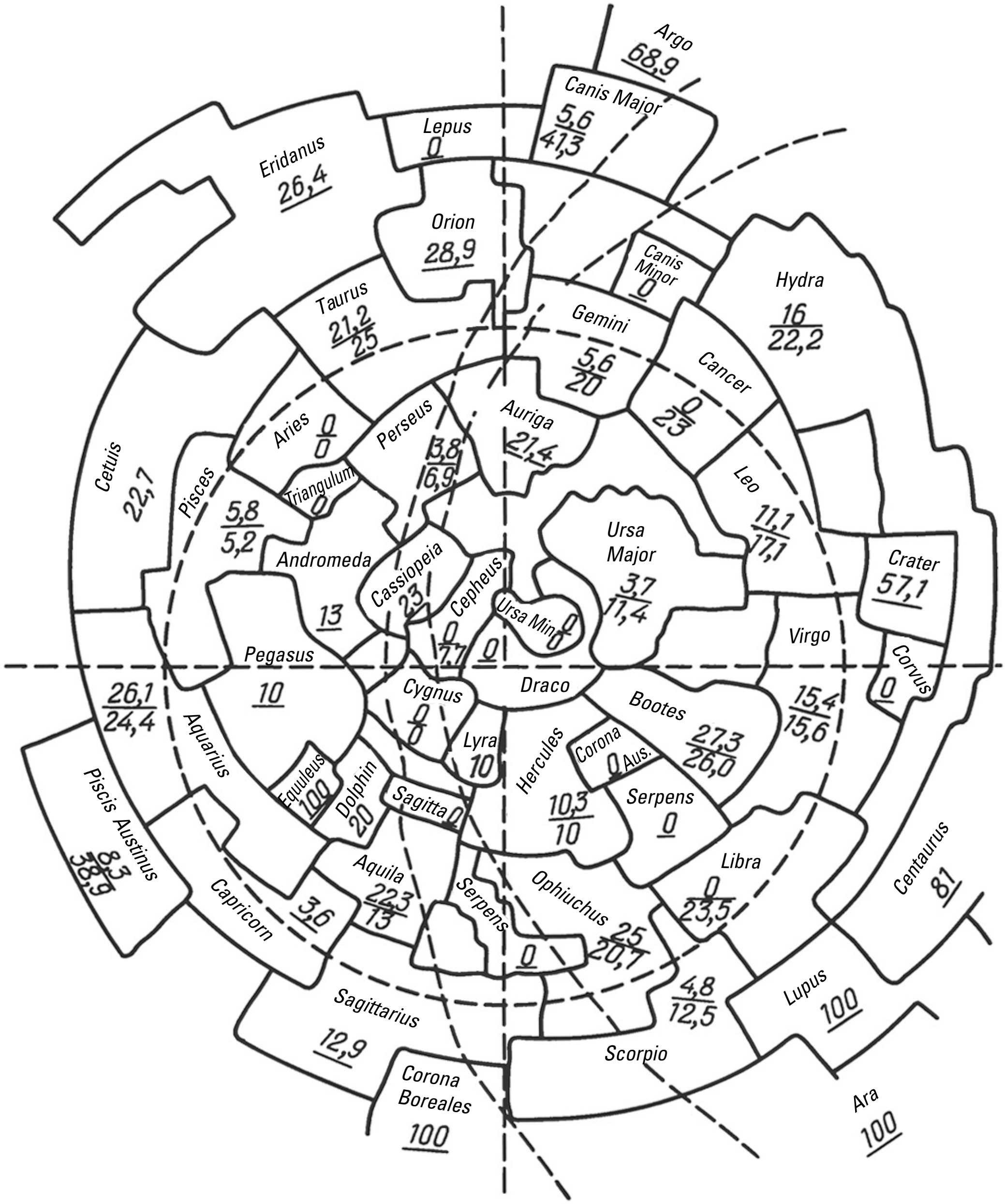


Fig. 2.15. Inside each of the constellations mentioned by Ptolemy and drawn as an area with zigzagged boundaries we specify two numbers, the first one corresponding to the percentage of poorly-measured stars in a constellation without informata, and the lower – to the same in a constellation with the informata added.

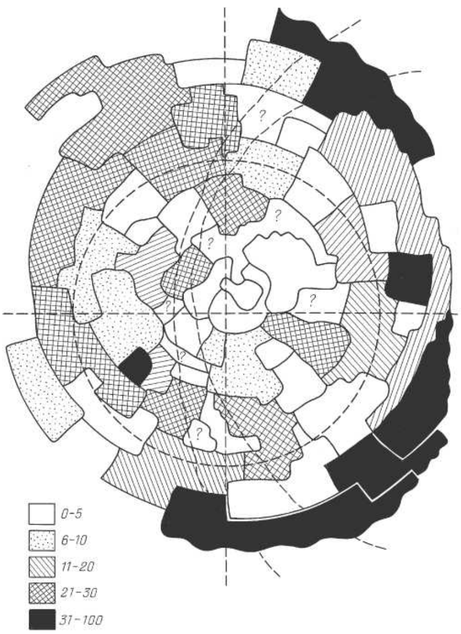


Fig. 2.16. A demonstrable representation of well-measured and poorly-measured celestial areas from the Almagest. The darker the area, the less accurate the corresponding measurements.

there is a lot of white here. Area *B*, which lays to the left of Area *M*, is measured worse than Area *A*, we see a good deal of double shading. Some of the areas in fig. 2.16 are marked with a question mark – they are the regions of the modern celestial sphere that formally remain beyond the confines of the Almagest constellations. Seeing as how the Almagest gives no precise definitions of constellation borders, neighbouring constellations may become "stretched" in such a way that they will fill the empty zones in fig. 2.16. We shall refrain from describing this procedure in greater detail - there are few such "blank spots", and they hardly influence our results in any way at all.

For a more illustrative analysis of the above picture, let us calculate the average percentage of poorly identifiable stars in each of the above seven areas individually by adding up the percentages calculated above for each of the constellations and dividing the sub by the total number of constellations for each area. The result is represented in table 2.3.

Corollary 3. Region *A* is measured better than regions *B, C, D* and *M* in the Almagest – namely, 6.3% of poorly identifiable stars in "pure" constellations and 12.6% in constellations with added *informata*.

Corollary 4. Region *B* is measured worse than region *A* in the Almagest, namely, we have 19.6% of poorly identifiable stars in the "pure" constellations and 19% in the constellations with the *informata*.

Corollary 5. Region *M*, or the Milky Way, occupies an intermediate position between regions *A* and *B* – 10.5% of poorly identifiable stars in "pure" constellations and 10.3% in the constellations with *informata*.

Corollary 6. Regions *C* and *D* are measured the worst in the Almagest – namely, region *D* contains 27.4% of poorly identifiable stars in "pure" constellations and 36.9% in constellations with *informata* added. For region *C* the percentage of poorly identifiable stars equals 52.9% in "pure" constellations and 53.6% in constellations with *informata*.

Parts of the celestial sphere in the Almagest	*A*	*B*	*A w/o ZodA*	*B w/o ZodB*	*ZodA*	*ZodB*	*D*	*C*	*M*
Number of constellations	14	12	8	6	6	6	7	8	7
Constellation numbers in the Almagest	1-8, 24-29	16-23, 30-33	1-8	16-21	24-29	22, 23, 30-33	34-38, 47, 48	39-46	9-15
Percentage of poorly identifiable stars in "pure" constellations (w/o *informata*)	6,3	19,6	6,4	27,6	6,2	11,6	27,4	52,9	10,5
Percentage of poorly identifiable stars in constellations with *informata*	12,6	19	8,1	26,5	18,6	11,9	36,9	53,6	10,3
Percentage of reliably identifiable stars in "pure" constellations	93,7	80,4	93,6	72,4	93,8	88,4	72,6	47,1	89,5

Table 2.3. Average percentage of poorly identifiable stars as given for each of the seven areas individually.

Corollary 7. Region *Zod A* is measured best in the Almagest – it is the part of the Zodiac on the right of the Milky Way. It includes the constellations of Gemini, Cancer, Leo, Virgo and Scorpio. Here we have a mere 6.2% of poorly identifiable stars in "pure" constellations.

Corollary 8. Region Zod B is measured much worse than *Zod A*. Here we have 11.6% of poorly identifiable stars in "pure" constellations. Region *Zod B* comprises the constellations of Sagittarius, Capricorn, Aquarius, Pisces, Aries and Taurus.

In order to get a better idea of what the information in table 2.3 really stands for, we have drawn a diagram, which is reproduced in fig. 2.14. Different kinds of shading correspond to different levels of measurement precision, or the percentage of dubiously identified stars. The white zone stands for areas that contain 0% to 10% of such stars, dotted shading corresponds to levels of 10%-20%, linear shading – to those of 20%-30%, and double shading represents zones of the celestial sphere that contain 30% to 100% of stars whose identity is ambiguous.

Another illustrative representation of the above information can be seen in fig. 2.17. The numbers of all 48 Almagest constellations are placed horizontally in such a way that they form groups, such as *A, B, Zod A, Zod B, A – Zod A* (*A* without *Zod A*, that is), *B – Zod B, C, D* and *M*. The respective percentage of dubiously identified stars in "pure" constellations is aligned vertically. Each of the constellation groups as listed above is represented by a certain horizontal segment in fig. 2.17 – the average percentage value for the group under consideration. Fig. 2.17 makes it perfectly obvious that the coordinates of stars in "group *A*" were measured with maximum precision (regions *A, Zod A* and *A – Zod A*). Corresponding values are the smallest. "Group *B*" is located much further up in fig. 2.17, which stands for lower measurement precision in this area. It is also apparent that the stars of the Southern Hemisphere were measured even worse.

The same information can be found in fig. 2.18, which is based on the last line of table 2.3, where the dubiously identified star percentage values in "pure" Almagest constellations are aligned vertically. This graph is obviously implied by the graph in fig. 2.17 and represents the values of the latter subtracted from 100%.

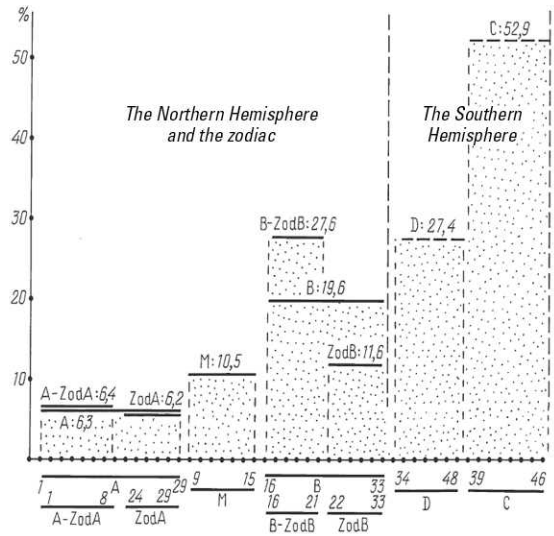


Fig. 2.17. Percentage of dubiously identified stars in the "pure" constellations of the Almagest, without accounting for the stars listed in the informatae. It is quite obvious that the stars from "group *A*" were measured the best, and the percentage of dubious stars here is the lowest.

Corollary 9. The first primary statement. The seven regions of the Almagest star atlas that we have discovered differ by the precision of stellar coordinate measurements. Indeed, different kinds of shading correspond to the seven celestial regions as described above (*A, B, C, D, M, Zod A* and *Zod B*) in fig. 2.14.

Corollary 10. The second primary statement.

1) Further research of star coordinates in the Almagest has to be based on the stars from region *A* first and foremost, since it is the most accurately measured region with a minimum of dubiously identified stars.

2) One mustn't base any corollaries on the study of the stars from regions *C* and *D*. An exceptionally large number of poorly identifiable stars in this area tells us quite explicitly that the regions in question cannot be considered reliably measured. Refraction is one of the reasons why the southern stars could not be measured with sufficient precision by the author of the Almagest – it is common knowledge that the coordinates of the stars located close to the horizon are affected by light refraction.

3) We get the opportunity to differentiate the list of 12 named stars by the level of their "reliability". The

stars measured with the greatest accuracy correspond to region *A* and its immediate vicinity. They are Regulus, Spica, Previndemiatrix, Procyon, Arcturus, Acelli, Antares, Lyra (Vega), and Capella. The "ambiguous" stars are Sirius (region *D*), Aquila, or Altair – region *B*, left border of the Milky Way, and Canopus, which is altogether off the chart. These stars ended up in the "poorly measured" celestial regions.

Incidentally, the star Previndemiatrix also has to be excluded from the list of "good" named stars for the following reason. Although this star can be identified quite well (in particular, it is absent from the list of poorly identifiable stars, qv in table 6 in [1339]), its coordinates as given in [1339] are rather uncertain and not substantiated with any references to the original Almagest manuscripts. Peters reports the following about the coordinates of the star Previndemiatrix in the Almagest: "Greek sources indicate 20°10', and the Arabs - 15°10' [a discrepancy of five degrees, no less – Auth.]. Ulugbek's catalogue contains the coordinates of 16°15'. Peters states 16°0', following the catalogue of Halma, likewise Bailey – however, he points out that Halma gives no authoritative references. It is clear that Halma's 16°0' were taken from Halley, which is correct [?! – Auth.] but not supported by any manuscripts" ([1339], page 104). It is clear that a situation as ambiguous as this one requires the star Previndemiatrix to be excluded from further consideration.

Thus, eight out of twelve named stars of the Almagest end up in the "reliably measured" region of the celestial sphere: Regulus, Spica, Procyon, Arcturus, Acelli, Antares, Lyra (Vega), and Cappella.

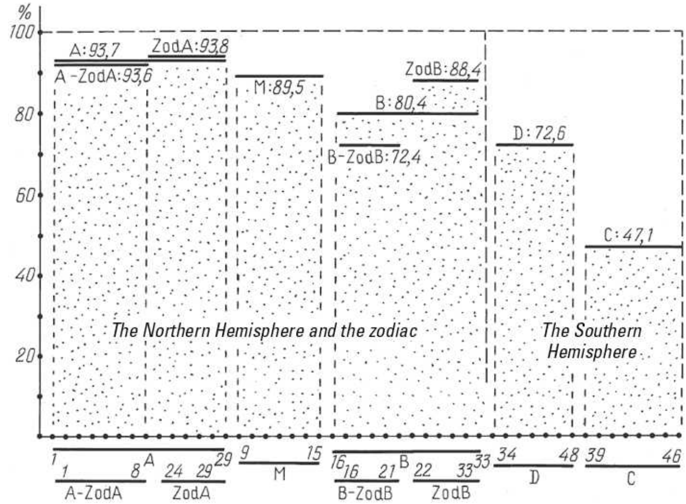


Fig. 2.18. Percentage of reliably identified stars in the "pure" constellations of the Almagest.

4. POSSIBLE DISTORTION OF THE STAR COORDINATES RESULTING FROM THE ATMOSPHERIC REFRACTION

A researcher of a star catalogue must always remember the physical phenomenon of refraction, whose influence can greatly distort the coordinates of the southern stars.

The phenomenon of refraction owes its existence to the properties of the atmosphere that affect the measurements conducted from the surface of the Earth; the latter is the case with all the ancient observations. From the mathematical point of view, the atmosphere of the Earth can be regarded as a set of concentric spherical air layers whose density is more or less uniform, changing from layer to layer.

It is common knowledge that a ray of sunshine is subject to refraction as it moves between different atmospheric layers of different density (see fig. 2.19). The ray becomes more vertical as a result, approximating the normal, which is the perpendicular border of two layers.

In fig. 2.20 we see a diagram of the Earth's atmosphere, presented as a set of concentric layers whose density diminishes as altitude grows. A ray of light that comes from star *A* refracts as it moves from one layer to another. As a result, it moves through the atmosphere forming a certain curve that can be calculated from the corresponding equation. This was done in the theory of atmospheric refraction. The result is shown in fig. 2.20 – the observer located in point *O* on the surface of the Earth perceives star *B* as part of half-line *OB*, while in reality the direction is represented by half-line *OA'*. Therefore, refraction "lifts" stars in a certain way.

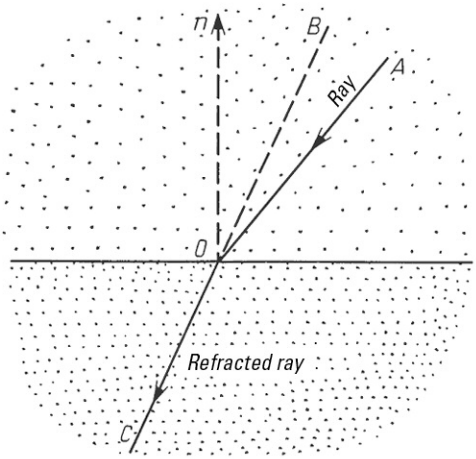


Fig. 2.19. Refraction of a ray of light at the boundary between two different environments.

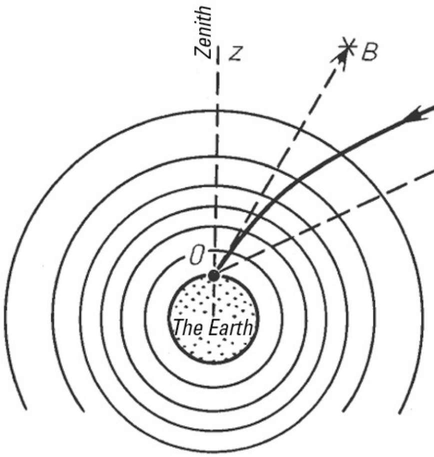


Fig. 2.20. Atmospheric refraction can distort the visible position of a star on the celestial sphere.

The closer a star happens to be to the horizon, the longer it will take a ray of light to get through the atmosphere of the Earth and the greater the "elevation" of the star. However, if the star is situated high enough, the distortion of its position shall be negligibly small. The theory of refraction has an approximated expression that characterises the refraction of zenith distances – namely, stellar zenith distance ζ, or the angle between the direction of zenith at the point of observation and the star direction, minus the value approximately expressed in the following formula (for $\varsigma < 70°$):

$$\rho = 60'' \frac{B}{760} \cdot \frac{273°}{273°+t°} \tan\zeta.$$

ζ stands for the zenith distance, B is the height of the barometer's mercury column at the moment of observation rendered to 0° centigrade, and $t°$ is the air temperature in degrees (centigrade) at the observation location. The above formula demonstrates that the main variable component that affects refraction is $\tan\zeta$. If the zenith distance is small (and the star is high enough above the horizon), the value of $\tan\zeta$ is small also, and the refraction is insignificant.

As the stars get closer to the horizon, the value of component $\tan\zeta$ grows, and refraction distorts stellar coordinates to a greater extent. This must be the reason why southern stars, which hang low above the horizon, were measured rather badly in the Almagest and the ancient catalogues in general.

We have already been confronted by this fact in section 3, having witnessed the fact that the percentage of poorly identifiable stars in regions *C* and *D*, which correspond to the southern part of the celestial sphere, happens to be much higher than in regions *A* and *B*.

It would be apropos to remark that the phenomenon of refraction was unknown to the ancient astronomers, and even upon its discovery the precise compensation of refraction remained a formidable problem – one that was only successfully solved in the epoch of Tycho Brahe. However, as it is mentioned in [65] (page 129), Tycho Brahe's compensation calculations were "rather far from perfection".

5. THE ANALYSIS OF THE INFORMATA DISTRIBUTION ACROSS THE ALMAGEST CATALOGUE

Table 2.2 contains the information about the distribution of the *informata* across the Almagest constellations. The table demonstrates that many constellations possessed no *informata* at all – namely, only 22 Almagest constellations out of 48 possess *in-*

formata. What is reflected in the presence or absence of *informata* stars in a given constellation? There may be many opinions on this issue. The one we consider to be the most plausible is as follows (it can be formulated in brief as the following hypothesis):

The *informata* were only indicated for the constellations that Ptolemy believed to be the most important.

In other words, the very presence of *informata* in a constellation signifies that the astronomer was particularly interested in said constellation.

It is possible that certain constellations were of particular importance and therefore marked as such on the celestial sphere. We do not ponder the reasons why there was an emphasis on these constellations – these reasons are of no importance to us and may have been of an astrological nature, for example. The stars of such constellations would therefore be measured several times for greater observation precision. Also, it might be that the observer, upon listing the stars that form the actual constellation figure, or the stars of the "pure" constellation in our terminology, added some of the "background stars" thereto – that is to say, the stars that do not constitute the constellation's skeleton, but rather happen to be located in its immediate vicinity. This is how the *informata* may have come into existence.

As we already know, these stars (most probably regarded as "secondary") could be measured worse on the whole than the stars of the main constellation.

It would be interesting to observe the distribution of the *informata* across the star chart of the Almagest.

In order to provide a quantitative characteristic of this distribution, let us do the following. We shall calculate she share of the *informata* stars for each of the Almagest constellations – otherwise, the value of $c = (a / b) \times 100\%$, where a stands for the number of *informata* stars and b for the full number of stars in a constellation with the *informata* added thereto.

Thus, if there are no *informata* stars in a constellation, $c = 0$. Next let us calculate the full share of *informata* in all constellations, which constitute a separate group. We are referring to constellation groups *A, B, M* etc.

Therefore, for each of the seven regions of the star chart discovered above we shall calculate a certain quantitative characteristic – the average share of *informata* stars in a given group. The higher the share, the more stars ended up as *informata*.

The result is represented graphically in fig. 2.21. We are following the same principle here as in fig. 2.17, namely, placing the numbers of Almagest constellations grouped by region (seven regions all in all, qv in fig. 2.17) on the horizontal axis. The average share of stars in the *informata* is indicated on the vertical axis. As a result, there is a horizontal segment that corresponds to each area.

The information in fig. 2.21 has the following important implication.

Corollary 1. The distribution of "*informata* density" in the Almagest star catalogue is in perfect concurrence with the distribution of dubiously identified stars in the "pure" constellations of the Almagest.

The same corollary can be reformulated as follows. The more attention was paid to one of the constellation groups by the compiler of the catalogue, the more trustworthy the identity of the stars in this group.

Indeed, as we can see in fig. 2.21, the highest density of the *informata* can be observed in region *Zod A*. Next we have region *A*. Furthermore, region *A* was

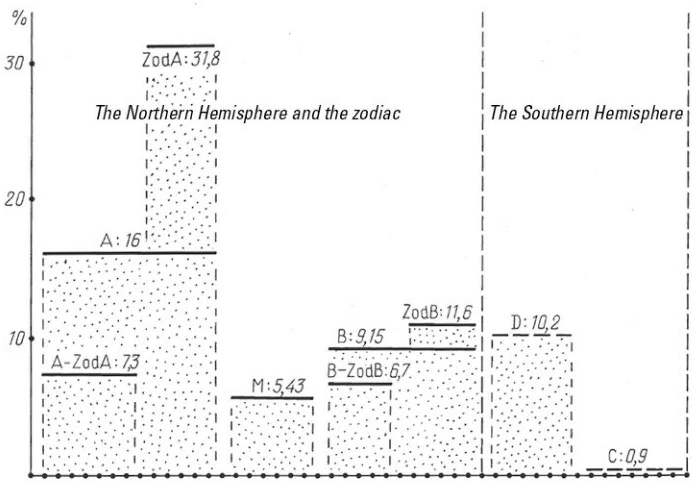


Fig. 2.21. The distribution of "*informata* density" in the Almagest star catalogue. We can see that this density is in perfect concurrence with the distribution of dubiously identified stars in the "pure" constellations of the Almagest.

clearly studied more attentively than region *B*. Region *M* was the least accurately measured part of the Northern Hemisphere. Regions *A* and *B* were observed with greater diligence than region *M*.

The least attention was paid to region *C* in the Southern Hemisphere. Although region *D*, also located in the Southern Hemisphere, enjoyed more attention from the part of the Almagest's compiler (poorly identifiable stars amounting to 10.2% here), this wasn't the case with region *C* (see fig. 2.17). Little wonder – regions *C* and *D* comprise the southern part of the Almagest star atlas, which is characterised by lower observation precision on the whole than the stars of the Northern Hemisphere and the Zodiacal constellations, as we have already mentioned repeatedly. Therefore, southern regions *C* and *D* must henceforth be considered separately and cannot be used in any conjectures due to low observation precision.

Thus, figs. 2.17 and 2.21 lead us to an important conclusion.

Corollary 2. The above analysis confirms the previously discovered division of the Almagest star atlas into seven regions of "varying precision". Observation precision for each of them is proportional to the amount of attention paid to this region. We are primarily referring to the Northern Hemisphere and the Zodiac. The higher the density of the *informata*, the better the measurements of the stars and the higher the percentage of reliably identifiable stars. The lower the density of the *informata*, the smaller the value corresponding to the percentage of reliably identified and "recognizable" stars. Detailed numeric data concerning individual Almagest constellations is cited in table 2.4 of Section 6, and this is the source that the reader may refer to. The share of *informata* is indicated for each and every constellation.

6. THE ANALYSIS OF THE COORDINATE VERSIONS AS SPECIFIED IN DIFFERENT MANUSCRIPTS OF THE ALMAGEST CATALOGUE. Comparison of the 26 primary manuscripts to the canonical version of the catalogue

The work of Peters and Knobel ([1339]) contains Table IX, where we see data that are at odds with the commonly used canonical version of the catalogue. These variances were discovered in the 26 primary "ancient" manuscripts of the Almagest. Table IX in [1339] contains all such versions. The following manuscripts were used in its compilation (see Chapter 11 for an exhaustive list of sources):

Greek manuscripts:
1) Paris 2389,
2) Paris 2390,
3) Paris 2391,
4) Paris 2394,
5) Venice 302,
6) Venice 303,
7) Venice 310,
8) Venice 311,
9) Venice 312,
10) Venice 313,
11) Vatican 1594,
12) Vatican 1038,
13) Vat. Reg. 90,
14) Laurentian 1,
15) Laurentian 47,
16) Laurentian 48,
17) Bodleian 3374,
18) Vienna 14.

Latin manuscripts:
19) Laurentian 6,
20) Laurentian 45,
21) Vienna 24,
22) British Museum Sloane 2795.

Arabic manuscripts:
23) British Museum 7475,
24) British Museum Reg. 16,
25) Bodleian 369,
26) Laurentian 156.

Table IX in [1339] contains 26 vertical columns corresponding to the above manuscripts of the Almagest. Each row of the table corresponds to some star from the catalogue whose coordinates differed from the canonical version. The table makes a very chaotic impression, since the versions are distributed randomly.

We must point out an important detail. Numbers (or versions) found in a single line of the table may coincide with each other, which means that several

manuscripts contain the same version (of the star's longitude, for instance) that differs from the canonical version.

Let us consider an example, assuming that the longitude of 16°10' is mentioned four times in a single table row, whereas the longitude of 16°20' is indicated in seven table cells. If we are to assume further that there are no other longitude versions in said table row, there will be exactly two longitude values that differ from the canonical in all 26 abovementioned manuscripts. We have simply considered the number of versions here, regardlessly of the number of repetitions – a more in-depth study would be very useful indeed. The total number of different stellar longitude versions (with repetitions) apparently equals 7 + 4 = 11.

Both numeric characteristics are important to us. The former is geometric and demonstrates the number of different dots, or stars, which have to be drawn on the celestial sphere in order to account for all the versions of this star's coordinates contained in the manuscripts. The second characteristic corresponds to manifestation frequency of a given version. It is obvious that the more manuscripts insist on a single version, the more reasons there are to try and find out why this particular version happens to be so popular.

Table IX is very voluminous as per [1339], and so there is hope of finding certain tendencies that will be useful to our research.

According to the Scaligerian viewpoint, the versions collected in Table IX ([1339]) result from scribes' errata that have accumulated over the centuries as the Almagest was copied many a time. The original of the Almagest is presumed to have been lost a long time ago, and has only reached us as several mediaeval copies. Each of the following copyists introduced new errata while copying the previous copy. As a result, we have several versions of the catalogue today. Of course, there could be errors made in the course of copying, since digits were transcribed as letters back then. Some letters can easily be confused for each other. This would lead to a certain distortion of the original numeric material. To sum up, we could say that Scaligerian history considers the differing manuscripts of the Almagest and its catalogue to be nothing but mechanical copies introduced by different scribes. Each of these copies is presumed to be the end product of a certain "copy tree" rooted in the lost original of the Almagest.

At the same time, it is possible that the catalogue wasn't merely copied, but rather complemented by new observations conducted in the epoch of the scribe. New coordinates could be introduced into the catalogue as a result – the ones that the mediaeval researcher believed to be more precise than the originals. It is therefore possible that the surviving versions of the catalogue have reflected both kinds of discrepancies – mechanical errata of the scribes as well as the results of independent star observations and repeated coordinate measurements. Which versions constitute the majority? Which of the two versions that we formulate below happens to be closer to the truth?

1) Contradictory versions we have at our disposal today are nothing but errata introduced by the scribes.

2) Discrepancies between versions are primarily a result of repeated independent measurements of star coordinates conducted by a single observer (or group of observers) during a single epoch. The estimation of the epoch is a separate task.

In other words, is it possible that the differing versions we have today aren't necessarily copies of the source catalogue – some are "drafts", which were used for the compilation of the catalogue's final canonical version. In order to find out which of the two postulations is closer to the truth, we have processed table IX in [1339] and collected the results in table 2.4. Let us comment on the principle of our table's construction. It contains seven columns and 48 rows.

The *first column* contains the constellation numbers according to the list in the Almagest.

The *second column* contains the name of the constellation (with the sum total of stars in the constellation indicated in parentheses).

In the *third column* we have the number of stars in the *informata* of the constellation in question (with 0 used for constellations without the *informata*). The percentage value of stars in a constellation comprised by the *informata* is indicated as well.

In the *fourth column* we see the full number of versions for longitudes and latitudes, as well as repetition frequency per single version (for the entire constellation with the *informata* included.

The *fifth column* corresponds to the full number of

Constellation numbers in the Almagest	*Name of constellations and the amount of stars in "pure" constellations (without informatae)*		*Amount of stars in an informata and its percentage in comparison with the constellation with its informata included*		*Number of options for latitudes and longitudes in a constellation with informata*			
					Full number		*Average number*	
					with miltiplicities	*w/o miltiplicities*	*with miltiplicities*	*w/o miltiplicities*
1	Ursa Minor	(7)	1	(12.5%)	73	29	9.1	3.63
2	Ursa Major	(27)	8	(22.8%)	227	103	6.49	2.94
3	Draco	(31)	0		150	89	4.84	2.87
4	Cepheus	(11)	2	(15.4%)	60	29	4.62	2.23
5	Bootes	(22)	1	(4.3%)	132	55	5.74	2.39
6	Corona Boreal.	(8)	0		25	17	3.13	2.13
7	Hercules	(29)	1	(3.3%)	202	79	6.73	2.63
8	Lyra	(10)	0		49	22	4.9	2.2
9	Cygnus	(17)	2	(10.5%)	95	45	5	2.37
10	Cassiopeia	(13)	0		60	28	4.62	2.15
11	Perseus	(26)	3	(10.3%)	87	49	3	1.69
12	Auriga	(14)	0		68	35	4.86	2.5
13	Ophiuchus	(24)	5	(17.2%)	213	85	7.34	2.93
14	Serpens	(18)	0		92	36	5.11	2
15	Sagitta	(5)	0		43	12	8.6	2.4
16	Aquila	(9)	6	(40.0%)	49	36	3.27	2.4
17	Delphinus	(10)	0		72	33	7.2	3.3
18	Equuleus	(4)	0		6	5	1.5	1.25
19	Pegasus	(20)	0		68	39	3.4	1.95
20	Andromeda	(23)	0		78	39	3.39	1.7
21	Triangulum	(4)	0		9	5	2.25	1.25
22	Aries	(13)	5	(27.7%)	83	41	4.61	2.28
23	Taurus	(33)	11	(25.0%)	259	110	5.89	2.5
24	Gemini	(18)	7	(28.0%)	192	60	7.67	2.39
25	Cancer	(9)	4	(30.7%)	107	44	8.23	3.38
26	Leo	(27)	8	(22.8%)	170	83	4.86	2.37
27	Virgo	(26)	6	(18.7%)	207	87	6.47	2.72
28	Libra	(8)	9	(52.9%)	85	39	5	2.3
29	Scorpius	(21)	3	(12.5%)	56	31	2.33	1.3
30	Sagittarius	(31)	0		179	67	5.77	2.16
31	Capricornus	(28)	0		217	85	7.75	3.04
32	Aquarius	(42)	3	(6.6%)	207	109	4.6	2.42
33	Pisces	(34)	4	(10.5%)	246	96	6.47	2.53
34	Cetus	(22)	0		130	54	5.91	2.45
35	Orion	(38)	0		212	96	5.58	2.53
36	Eridanus	(34)	0		210	81	6.18	2.38
37	Lepus	(12)	0		71	36	5.92	3
38	Canis Major	(18)	11	(37.9%)	88	38	3.03	1.31
39	Canis Minor	(2)	0		12	5	6	2.5
40	Argo Navis	(45)	0		250	100	5.56	2.22
41	Hydra	(25)	2	(7.4%)	209	73	7.74	2.7
42	Crater	(7)	0		33	18	4.71	2.57
43	Corvus	(7)	0		20	17	2.86	2.43
44	Centaurus	(37)	0		179	70	4.84	1.89
45	Lupus	(19)	0		133	57	7	3
46	Ara	(7)	0		70	24	10	3.43
47	Corona Austr.	(13)	0		85	31	6.54	2.38
48	Pisces Austr.	(12)	6	(33.3%)	72	36	4	2

Table 2.4. Number of options for stellar coordinates in different constellations of the Almagest.

versions for longitudes and latitudes without repetitions given for the entire constellation, *informata* included.

The *sixth column* is the average number of different longitudinal and latitudinal values with number of repetitions (per constellation, whole, *informata* included).

The *seventh column* is the average number of different versions (longitudes and latitudes) – taken without repetitions for the entire constellation, *informata* included.

Let us comment the resulting table. The third column serves as the basis of fig. 2.21, which we discuss at length in Section 5. Values from this column correspond to informata density distribution in the Almagest star atlas.

The principle behind the calculation of values from columns 4 and 5 is obvious enough. We counted the full number of variations for every star in a given constellation, with all the repetitions included. The results for all stars in this constellation were subsequently added up. Let us emphasise that our current objective is to study the distribution of coordinate variations across the entire catalogue. We see that the Almagest constellations are anything but uniform in this relation. Some constellations are poor in variance. It has to be said that we did not consider longitudes and latitudes separately in this research, but rather studied their sum characteristics for more confident statistical corollaries.

7. VERSION DENSITY AS THE DENSITY OF INDEPENDENT STAR OBSERVATIONS. Seven areas of the Almagest star atlas revisited with a new concurrence with the previous results

In order to make conclusions from table 2.4 we shall perform an additional simple operation – namely, calculating the average amount of stellar coordinate versions for all of the seven areas of "varying precision" on the Almagest star chart as listed above. For this purpose we shall divide the rows of the last two columns of table 2.4 into seven groups (*A, B, M* etc), and then average the values from a single group. The result is presented as table 2.5. The fourth row of the table provides the basis for fig. 2.21 and shows the *informata* percentage for every celestial region.

The last two lines of table 2.5 are the most important for table 2.5. The fifth line shows the version density with multiplicities taken into account, whereas the sixth provides the same information without multiplicities, or repetitions. Let us turn to fig. 2.22 for a more demonstrative representation of these data. The horizontal line contains numbers of the Almagest constellations grouped by the seven areas of the star chart, see fig. 2.17. In the vertical we see the average amount of versions for each of these areas.

Tables 2.5 and fig. 2.22 lead us to the following corollaries:

Parts of the Almagest's celestial sphere	*A*	*B*	*A w/o ZodA*	*B w/o ZodB*	*ZodA*	*ZodB*	*M*	*D*	*C*
Number of constellations in an area	14	12	8	6	6	6	7	7	8
Compounds of an area (constellation numbers according to the Almagest)	1-8, 24-29	16-23, 30-33	1-8	16-21	24-29	22, 23, 30-33	9-15	34-38, 47, 48	39-46
Informata percentage in an area	16	9.2	7.3	6.7	31.8	11.6	5.4	10.2	0.9
Average number of versions for latitudes and longitudes (with multiplicities)	5.72	4.68	5.69	3.5	5.76	5.85	5.5	5.31	6.09
Average number of versions for latitudes and longitudes (without multiplicities)	2.53	2.23	2.63	1.96	2.41	2.49	2.29	2.29	2.59
Northern constellations and the zodiac							Southern constellations		

Table 2.5. Average number of versions for latitudes and longitudes in the Almagest constellations.

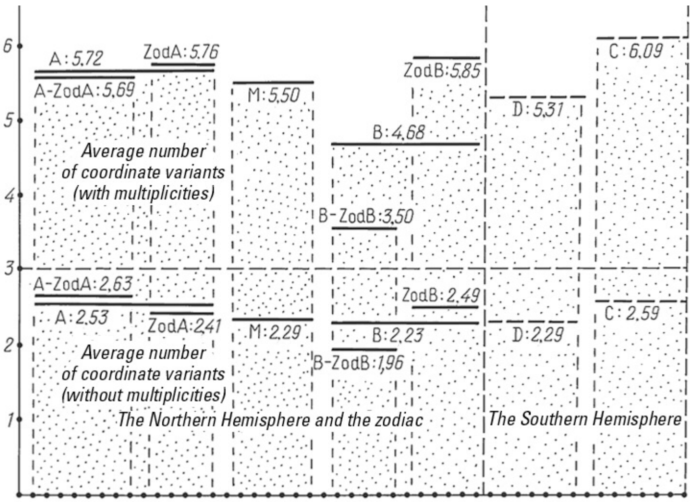


Fig. 2.22. Density distribution of stellar coordinate version numbers in the Almagest catalogue. Densities are given with and without multiplicities.

Corollary 1. The version density graph with multiplicities concurs well to the one without them.

This implies that the logical patterns listed below manifest in both graphs. Let us point out that the density graph without multiplicities has smaller amplitude fluctuations as compared to the density graph that accounts for multiplicities. This is quite natural, since when one includes them, the density fluctuations are observed more realistically; fig. 2.22 demonstrates precisely this.

Corollary 2. Star coordinate density on the Almagest star atlas concurs perfectly with the distribution of the reliably identified stars in pure Almagest constellations as well as the *informata* density distribution.

We present the information which concerns the distribution of said densities as four tables – 2.6, 2.7, 2.8 and 2.9. Table 2.6 demonstrates the distribution of safely identifiable stars in the pure constellations of the Almagest. The rows and the columns of the table correspond to the following regions that we discover on the Almagest chart: *A, B, A* minus *Zod A, B* minus *Zod B, Zod A, Zod B, M, D* and *C*. Three last columns and rows of the table refer to the areas of the Southern hemisphere.

The cells of the table contain + and – signs (or +=/–=, in some cases). Their meaning is as follows. Let us consider the first row of the table, for instance, which corresponds to area *A*. The respective percentage is larger for area *A* than for area *B*; therefore, we put a + on the crossing of the first row and the second column. Furthermore, the percentage is formally greater for area *A* than for *A* minus *Zod A*, but equal to the latter de facto; therefore, we put a += sign into the respective cell; should this percentage prove smaller, we use –; if smaller but equal de facto, –=.

	A	*B*	*A w/o ZodA*	*B w/o ZodB*	*ZodA*	*ZodB*	*M*	*D*	*C*
A	=	+	+=	+	–=	+	+	+	+
B	–	=	–	+	–	–	–	+	+
A w/o ZodA	–=	+	=	+	–=	+	+	+	+
B w/o ZodB	–	–	–	=	–	–	–	–=	+
ZodA	+=	+	+=	+	=	+	+	+	+
ZodB	–	+	–	+	–	=	–=	+	+
M	–	+	–	+	–	+=	=	+	+
D	–	–	–	+=	–	–	–	=	+
C	–	–	–	–	–	–	–	–	=

Table 2.6. A comparison of the percentage of reliably identifiable stars in the pure constellations of the Almagest (without informata) for different parts of the celestial sphere.

	A	*B*	*A w/o ZodA*	*B w/o ZodB*	*ZodA*	*ZodB*	*M*	*D*	*C*
A	=	+	+	+	–	+	+	+	+
B	–	=	+	+	–	–	+	–=	+
A w/o ZodA	–	–	=	+	–	–	+	–	+
B w/o ZodB	–	–	–	=	–	–	+=	–	+
ZodA	+	+	+	+	=	+	+	+	+
ZodB	–	+	+	+	–	=	+	+	+
M	–	–	–	–=	–	–	=	–	+
D	–	+=	+	+	–	–	+	=	+
C	–	–	–	–	–	–	–	–	=

Table 2.7. A comparison of informata density for various parts of the Almagest star atlas.

	A	*B*	*A w/o ZodA*	*B w/o ZodB*	*ZodA*	*ZodB*	*M*	*D*	*C*
A	=	+	+=	+	–=	–=	+	+	–
B	–	=	–	+	–	–	–	–	–
A w/o ZodA	–	+	=	+	–=	–=	+	+	–
B w/o ZodB	–	–	–	=	–	–	–	–	–
ZodA	+=	+	+=	+	=	–=	+	+	–
ZodB	+=	+	+=	+	+=	=	+	+	–
M	–	+	–	+	–	–	=	+	–
D	–	+	–	+	–	–	–	=	–
C	+	+	+	+	+	+	+	+	=

Table 2.8. A comparison of the relative stellar coordinate version numbers for various areas of the Almagest star atlas, with multiplicities accounted for.

	A	*B*	*A w/o ZodA*	*B w/o ZodB*	*ZodA*	*ZodB*	*M*	*D*	*C*
A	=	+	–=	+	+	+	+	+	–
B	–	=	–	+	–	–	–=	–	–
A w/o ZodA	+=	+	=	+	+=	+=	+	+	+
B w/o ZodB	–	–	–	=	–	–	–	–	–
ZodA	–	+	–=	+	=	–=	+	+	–
ZodB	–	+	–=	+	+=	=	+	+	–
M	–	+=	–	+	–	–	=	≈	–
D	–	+	–	+	–	–	≈	=	–
C	+	+	–=	+	+	+	+	+	=

Table 2.9. A comparison of the relative stellar coordinate version numbers for various areas of the Almagest star atlas, without multiplicities.

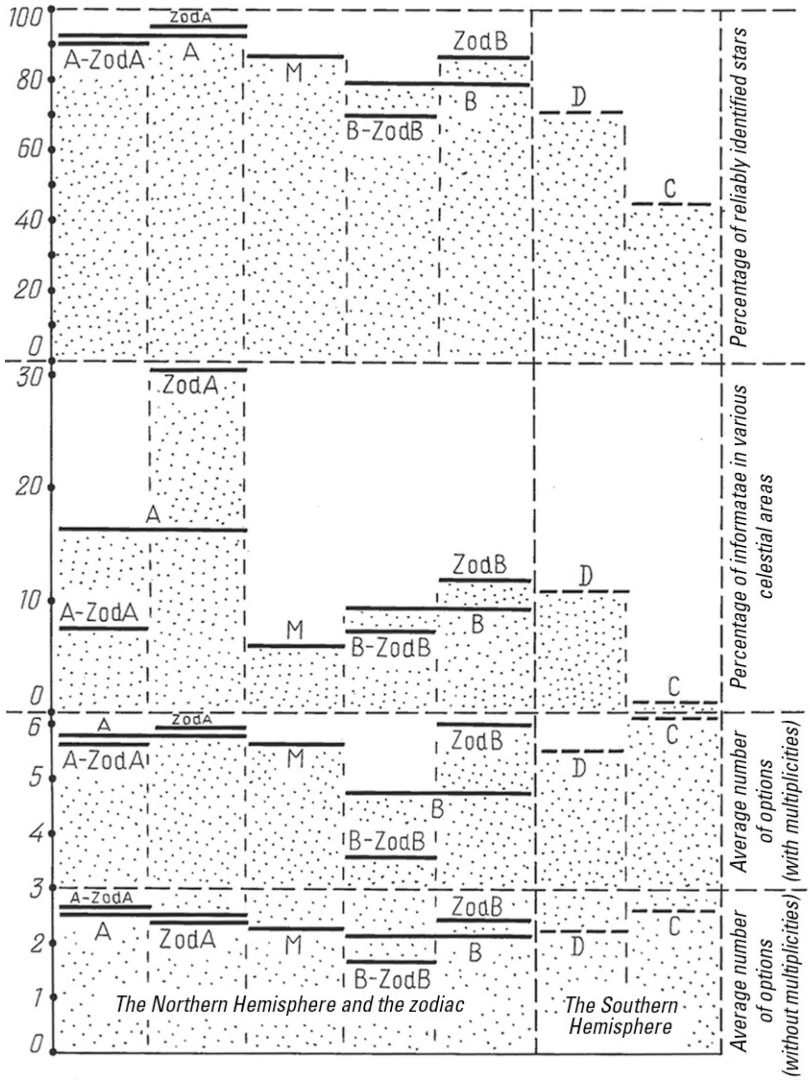


Fig. 2.23. A graph where we simultaneously see the following: 1) the distribution of whatever percentage the reliably identified stars of the Almagest catalogue comprise; 2) the percentage of informatae in various areas of the Almagest's celestial sphere, 3) average number of stellar coordinate options in various manuscripts of the Almagest, with multiplicities, 4) average number of coordinate options, without multiplicities. One can see that all four density graphs for the Northern Hemisphere correlate with each other well.

The implication is that when we look at table 2.6, we can safely tell the comparative percentage of reliably identifiable stars for every area pair. Table 2.6 is a compact representation of density distribution in all of the star chart areas described above.

The next three tables are based on the same principle. Table 2.7 demonstrates the *informata* density distribution for the Almagest star atlas, and table 2.8 gives us an opportunity to compare the version density of the Almagest stellar coordinates for different celestial areas. The versions that constitute this table were calculated with multiplicities, which means that if the same version was encountered several times, the entire amount was accounted for accordingly. If we

are to leave multiplicities out, or just count each version once, the result will be a comparative presentation of the relative coordinate version quantity for varying areas of the Almagest star atlas, qv in table 2.9.

Tables 2.6-2.9 make it obvious that the distribution of pluses and minuses is virtually equal, which implies a good correlation between the following four values:

1) the percentage of reliably identifiable stars in a given area of the Almagest star chart;

2) *informata* density in the Almagest star chart area in question;

3) stellar coordinate version density with multiplicities;

4) stellar coordinate version density without multiplicities.

In particular, the higher the *informata* density and the coordinate version density in a given area, the more reliable the identification of the stars located therein.

The implication is that we cannot interpret the coordinate versions presented in the 26 manuscripts of the Almagest exclusively as scribe errors. Had this been the case, this would lead us to the a priori false statement that the error rate growth for a given area results in better star identification. We must therefore reject the hypothesis about this abundance of versions being attributable to the inaccuracy of the scribes. In this case, the only reasonable explanation of the effect discovered can be rendered as follows.

The multitude of different stellar coordinate versions in the Almagest manuscripts results from independent star observations performed several times by an observer, or a group of observers. Due to the imprecision of the instruments used for these observations, the results would often differ from each other. The more measurements of a given star's coordinates were performed, the more versions would get into manuscripts. Therefore, the areas of the star chart with high coordinate version density are the ones whose stars were observed several times with their coordinates measured anew; in other words, these areas enjoyed more of the researchers' attention than the others. It is natural that the more attention a given celestial region got, the more dependable the identifications of the stars it contains. As we shall demonstrate in the subsequent chapters of our book, the coordinates of those stars were indeed measured a great deal better on the average in Ptolemy's epoch.

Thus, if we are to simplify the situation somewhat, one has reasons to presume that the 26 primary manuscripts of the Almagest are for the most part its "drafts" rather than mechanical copies. They were subsequently used for the creation of the final canonical text. The Scaligerian version of these manuscripts' origins does not concur with our conclusion. Indeed, why would mediaeval scribes copy the "drafts" together with the "final version" for centuries of end? It would make a great deal more sense if we are to assume that both date to approximately the same epoch, and the number of copies was far from great. Let us reiterate that observations of this manner shall not be used in our research; they are but a number of naturally arising questions which are to demonstrate several possible explanations of the effect that we discovered, nothing more.

Finally, let us cite fig. 2.23 where we combine all of the above density distribution graphs into one. The dependency between various graphs is obvious.

8. IN RE THE RELIABILITY OF LATITUDINAL AND LONGITUDINAL MEASUREMENTS CONTAINED IN THE ALMAGEST

8.1. According to Robert Newton, the longitudes in the Almagest were re-calculated by somebody; however, this suspicion does not arise insofar as their latitudes are concerned

Let us begin with the commentary in re the Almagest measurement precision made by R. Newton, the astronomer. In general, we are of the opinion that these observations of his are applicable to a wider spectrum of issues. R. Newton actually gives us a very forthright account of a rather meandrous scenario around the readings and interpretations of a great number of "ancient" astronomical documents. He is referring to "the so-called principle of 'error immortalization', which can be formulated as follows. Let us assume that the error of author *A* became published, and a later author *B* is referring to it in some manner deeming the erroneous statement veracious. Thus the

error becomes immortalized in scientific literature; erasing it from scientific literature becomes an impossibility. One can hardly be serious about there being no exceptions for this rule; however, there is a great number of examples that do follow this principle – readers are likely to have quite a few such examples of their own" ([614], page 165).

Something similar appears to be happening with the Scaligerian interpretation of the Almagest – its dating in particular. The analysis of the Scaligerian version, which dates it to the beginning of the new era requires a new study of its content. This is a complex scientific problem that requires a great deal of labour. We accomplish a significant part of this task in our research, and the reader has the opportunity to evaluate the complexity of this task. The main difficulty is that one has to get to the very roots of this or the other scientific statement or opinion. It appears that their overwhelming majority was initially made with the a priori or taciturn presupposition that the Almagest dates to an early A.D. century. Our "excavations" required the analysis of source material, which requires a great deal of work by itself.

Let us now get back to the issue of the complexity of latitudinal and longitudinal measurements. In Chapter 1 we already explain that the very nature of the ecliptic and equatorial coordinates allows to measure the latitudes more securely than the longitudes.

Also, the use of an *armilla,* for instance, can generate errors if the astronomer makes an incorrect ecliptic inclination choice. The matter is that the observer has to determine the angle between the ecliptic and the equator and then fix it in order to use the instrument for the measurement of stellar coordinates, for instance, having adjusted it in accordance with the previously found ecliptic inclination. In general, the *armilla* can be adjusted by any object whose latitude and longitude are known. Ptolemy often used the Moon for this purpose. This makes it possible to calculate the coordinates of any other object that might interest us. However, in this case, as R. Newton is perfectly correct to remark, the imprecisions in the determination of the known object's coordinates automatically lead to incorrect calculation of the second object's coordinates ([614], page 151).

It also has to be borne in mind constantly that in case of the Almagest we are dealing with copies where numbers were transcribed as letters. This would frequently cause confusion. For instance, according to the astronomers R. Newton ([614], page 215), Peters and Knobel ([1339]), one could easily confuse the "ancient" Greek digits for 1 and 4 due to the fact that the figure of 1 was transcribed as α, and one of its widely-used old forms was very similar to the letter δ, which stood for 4 – hence the confusion.

One has to make an important observation in this respect. Our research is based on the canonical version of the Almagest star catalogue translated in the work of Peters and Knobel ([1339]). As R. Newton points out, "a careful comparison of various manuscript often reveals the errors made in the process of multiple copying and gives the researcher an opportunity to correct them. Peters and Knobel studied the "Syntaxis" [Almagest – Auth.] with the utmost attention; it is possible that their version of this catalogue is the most precise of all" ([614], page 216).

We shall also be using the detailed analysis performed by the astronomer Robert Newton in the large special chapter IX of his book ([614]) in order to evaluate the reliability of the longitudes and latitudes as given in the Almagest. We shall omit the details pertaining to the statistical analysis conducted by R. Newton and merely cite his results.

R. Newton wrote that "the latitudes in the star catalogue were most probably measured by a single observer employing a single instrument for the purpose" ([614], page 253). Further also: "the latitudes educed from the observations were put down in the catalogue without alterations (it is however possible that there were errors in the transcription)" ([614], page 249). According to R. Newton, the latitudes of the Almagest star catalogue are a reliable enough body of material obtained as a result of actual observations performed by either Ptolemy or one of his predecessors (Hypparchus, for instance). This concurs perfectly well with the information cited above that shows latitudinal measurements to be a lot simpler as a procedure than the longitudinal, therefore, stellar latitude is a more reliably measurable coordinate.

The picture with the longitudes is drastically different. R. Newton claims that "the longitudes weren't deduced from any observations whatsoever … the longitudinal values are fabricated" ([614], page 249). Further also: "the multitude of longitudes contained

in the star catalogue is highly unlikely to have been determined from observations" ([614], page 250). We have already explained to the reader that the measurements of ecliptic longitudes prove to be a lot more sophisticated and complex procedure than longitudinal measurements. Furthermore, it is presumed that the longitudes in the Almagest catalogue were rendered to 137 A.D. Such a rendition to an a priori chosen date is quite simple; all it takes is adding some common constant to the ecliptic longitudes of all the stars. This constant is proportional to precession and depends on how much older the compiler of the catalogue really wanted the longitudes to look. R. Newton is of the opinion that the original longitudes obtained by the ancient observer experimentally were subsequently re-calculated anew by someone else. This is his fundamental solution based on the analysis of how frequently degree fractions appear in the catalogue: "Longitudes were altered. Observation results were made greater by several degrees and 40 minutes" ([614], page 249). This operation (an addition of a whole number of degrees whose value could be either positive of negative, with a couple of fractions) could make the catalogue either gain or lose a considerable amount of age at the will of its compiler or forger. Bear in mind that such an operation would be either altogether impossible with latitudes, or a great deal more complicated at the very least. However, we cannot determine how many grades exactly were either added to the initial longitudes or subtracted therefrom if we are to base our research upon nothing but the longitude analysis in the existing copies of the Almagest. R. Newton points out the very same thing: "The actual distribution of grade fractions tells us nothing of just how many grades were added to the initial longitude by Ptolemy" ([614], page 251).

Apart from the simple operation of shifting all the longitudes by an unknown number of grades mentioned above, R. Newton discovered traces of finer longitudinal recalculations ([614], pages 246-247). Thus, someone had conducted an extensive body of work in the field of recalculating the initially observed longitudes. Therefore, the modern list of longitudes that we find in the Almagest does not represent the actual observational material, but rather the likely result of its having been processed in a certain rather complex way which was meant to help meeting a certain end. According to N. A. Morozov, for instance, this end could be formulated as giving the catalogue an arbitrary amount of extra age – in other words, we have a case of falsification. However, we shall refrain from taking any sides a priori and analyze longitudes and latitudes both together and separately.

Let us conclude with another summary made by R. Newton: "We get an altogether different picture from the longitudes [as compared to the latitudes – Auth.]. No colourable explanation can possibly be given to the fraction distribution in longitude, regardless of whether or not the observations were in fact performed by a single person who had used a single instrument for this purpose" ([614], pages 146-247).

8.2. Examples proving that the dating of the star catalogue by longitudinal precession often leads to great errors. Mediaeval catalogues are subject to becoming erroneously dated to an antediluvian epoch

The Scaligerian version of astronomy often uses the following apparently simple method for catalogue dating. The ecliptic longitudes of the old catalogue's stars are compared to the modern longitudes. The resulting difference, which is roughly the same for all the stars, is then divided by the precession value, which equals roughly 50 seconds per year or one degree in 70 years. This is how the historians determine the residual between the dates of the modern catalogue and those contained in the old one. In particular, this method allows to "deduce" the ecliptic coordinates from the 1538 edition of the Almagest as equalling those which roughly correspond to some early A.D. epoch.

However, the "method" described above makes the taciturn implication that the compiler of the old catalogue would count ecliptic longitudes from the vernal equinox point of his era, or the epoch when the star observations were conducted. Had this indeed always been the case, the resulting residual accumulated by today could really be considered a result of precession. Assuming this to be true, the method described above would indeed give us the approximate date of the old catalogue's creation. However, it is important to emphasise that it wasn't in fact a charac-

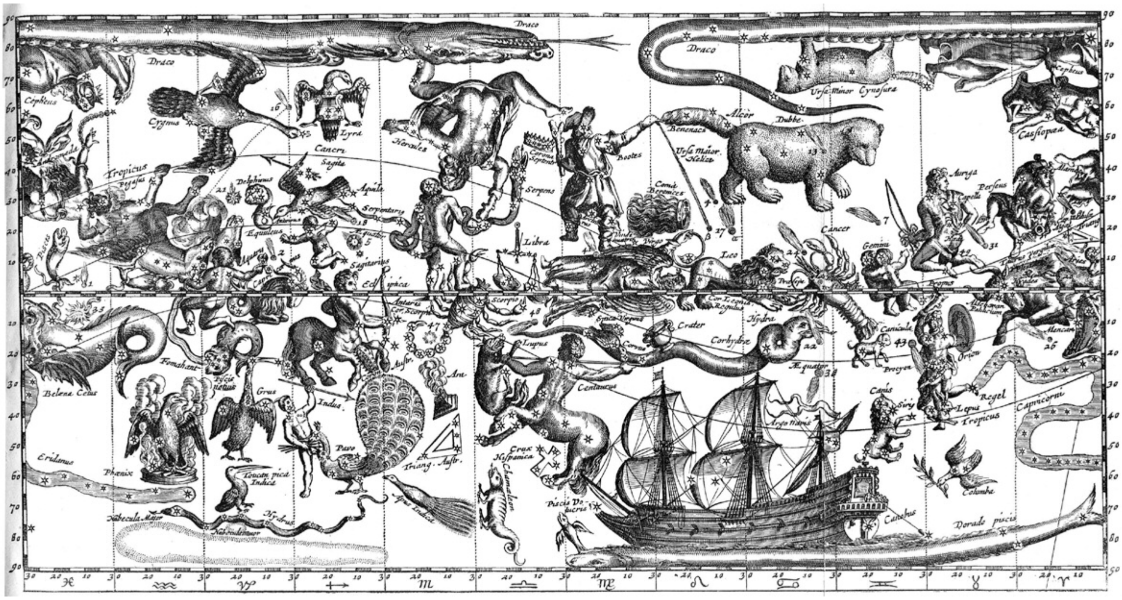


Fig. 2.24. Star chart from a XVII century book by Stanislaw Lubienietski. One sees that the Gamma of Aries was chosen as the initial longitudinal reference point. This is where the equinoctial crosses the ecliptic. Taken from [543], inset between the pages 26 and 27.

teristic of all the ancient authors to use the vernal equinox point of their own epoch for the initial reference point.

Let us linger on the above for a while. One shouldn't get the impression that the astronomers of as recent an epoch as the XVI-XVII century necessarily count the longitudes in the exact same manner as the modern astronomers. We shall refer the reader to the well-known ***Cometography*** by the mediaeval author Stanislaw Lubienietski published in 1681: S. de Lubienietski, ***Historia universalis omnium Cometarum*** ([1257]). This book is a priori known to have been written in the XVII century. It lists many comets observed up until the year 1680. S. Lubienietski, its author, belonged to the XVII century school of astronomers, preceding our time by a mere 300 years. Let's take a closer look at how Lubienietski counts the longitudes on his star charts. We discover that he uses the meridian crossing the γ star from the Aries constellation as the initial celestial meridian, qv in fig. 2.24. The "sine curve" that stands for the equinoctial, or the celestial equator in this projection, is directly referred to as "Aequator" here, which is the legend that we see over the masts of the Argonaut ship from the constellation of Argo Navis, closer to the right end of the map, and once again near the constellation of Ophiuchus near the left end of the map – see fig. 2.24. The ecliptic is represented by a thick horizontal line with degree grades. One can see perfectly well that the ecliptic and the equator cross right where the map boundary is located – at the γ star of the Aries constellation. There can be no doubt about this (see figs. 2.25 and 2.26).

Thus, all the stellar longitudes indicated by S. Lubienietski were smaller than the ones we find in the Greek longitudes from the 1538 Almagest by roughly 7 degrees (see the respective comparative tables as well as the actual charts in [544], Volume 4, pages 233-234, and also [543], inset between pages 26 and 27).

Let us retort to the strange "logic" of the Scaligerite historians which they advocate with such persistence and even obstinacy in their dating of the Almagest by the longitudes of the Greek edition, thereby implying Lubienietski to have counted the coordinates beginning with the vernal equinox point of his epoch. In that case his book will have to be dated to the V century B.C., since this is when "the vernal equinox point was really located near the first stars of the Aries con-

stellation, qv in Lubienietski's case", according to the most apropos comment made by N. A. Morozov [544], Volume 4, page 33. However, Lubienietski's book was written in the XVI century!

The ensuing absurd corollary is yet another proof of how careful one has to be in one's dealings with the "dating method" described above – which, as we feel obliged to reiterate, has always been used by the Scaligerian historians in case of the Greek edition of the Almagest.

All of the above implies lucidly that the astronomers of the XV-XVII century A.D. hadn't yet come to any unified agreement concerning the initial reference point for the longitude count. The unification epoch would come after quite a while. Each astronomer would select his own point of reference guided by considerations of his very own. Lubienietski, for one, used the first stars of the Aries constellation for this purpose. As for the Greek edition of the Almagest, the star coordinates were counted from the meridian that crosses the ecliptic at the point whose longitudinal distance to the γ of Aries equals 6°40'.

Lubienietski's case is by no means unique. The star catalogue compiled by Copernicus provides for a more impressive example. Copernicus also counts the longitudes beginning with the γ of Aries, just like Lubienietski (or, rather, the latter follows the tradition of Copernicus). The only difference is that the γ of Aries occupies the longitude of zero in the catalogue of Copernicus ([1076]). The latter gives its coordinates as equalling 0 degrees 0 minutes of longitude, and 7 degrees 20 minutes of latitude (see [544], Volume 4, pages 224 and 227). Thus, if we decided to "date" the catalogue of Copernicus using the "Scaligerian method" described above, we would also date it to times immemorial, which would be perfectly erroneous since it is presumed that Copernicus had lived in the XV-XVI century (1473-1543).

Thus, the precession of the stellar ecliptic longitudes cannot serve for any secure dating of the catalogue whatsoever.

The varying initial reference points used for longitude count in the works of the XVI-XVII century authors as indicated above shouldn't surprise us at all. There were many different astronomical schools at the dawn of this discipline, which would often compete with each other and adhere to different catalogue compilation rules etc. It is well possible that each school remained loyal to a tradition of its own which specified the rules for choosing the basis points, reference points and so on. The considerations for such a choice may have been astronomical, religious, or of an altogether different nature.

It was only when astronomy developed into a grown science when the necessity of a unified system

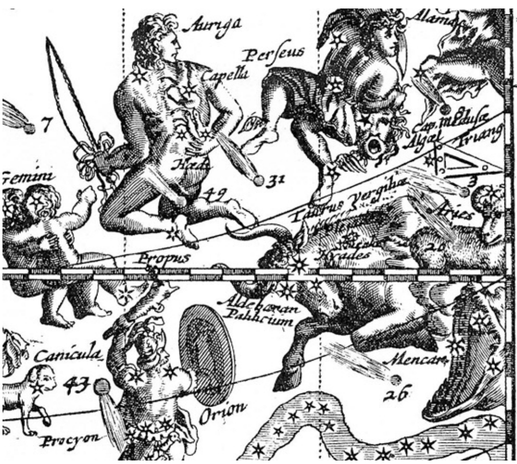


Fig. 2.25. A fragment. Right side of Lubienietski's chart, where the equinoctial crosses the ecliptic near the Gamma of Aries ([1257]). Taken from [543], inset between the pages 26 and 27.

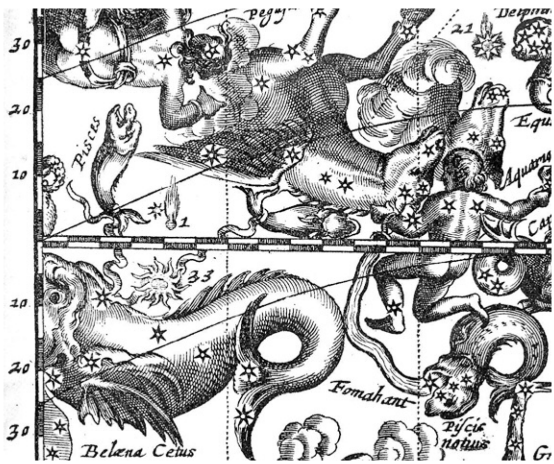


Fig. 2.26. A fragment. Left side of Lubienietski's chart, where the equinoctial crosses the ecliptic near the Gamma of Aries. Taken from [543], inset between the pages 26 and 27.

of indications and concepts was realized that the astronomical language became more uniform. In particular, the vernal equinox point was agreed upon as the initial reference point (an invisible one, as a matter of fact; furthermore, its celestial position changes with the passage of time). This point cannot be affixed to some star located nearby. It is therefore hardly surprising that certain mediaeval astronomers would use an actual star for reference instead of the equinox point – the γ of Aries, for instance.

When we study the Almagest star catalogue in our book (the same is indeed true for other old star catalogues), we make sure our research is in no way dependent on any presumptions that concern the particular longitudinal reference point used by the catalogue compiler. There are no such indications in the actual star catalogues, after all. Our opponents might counter that a direct reference to the choice of the equinox point for the measurement of longitudes can be found elsewhere in the Almagest.

However, if we are to be guided by such notions, it shall imply the use of some "extraneous" or foreign information which, as we must emphasize, is not contained in the star catalogue itself. However, our goal is to date the catalogue by its own internal characteristics without citing any external sources. As for the issue of determining the dating of the remaining texts together with its genesis is a problem of its own, and one that possesses no reliable single solution (see [544] and [614]).

9. THE DUBIOUS NATURE OF THE TRADITIONAL OPINION THAT PTOLEMY'S TEXT IMPLIES ACTUAL "OBSERVATIONS" ON HIS PART, as well as his "personal participation" in the stellar measurements and observations described in the Almagest

Ptolemy's text can by no means imply the veracity of the consensual opinion, namely, that all the observations and measurements that the Almagest contains were performed by the author in person. Its actual text allows for several interpretations. However, what we are most likely to be seeing here represents the research result of a great many astronomers and not a single author's account of his own observations. Apart from that, the Almagest is basically a textbook, or a guidebook for young astronomers and scientists in general that contains descriptions of varying observation methods etc – a mediaeval astronomical encyclopaedia of sorts. Here are a few examples to confirm this. We shall be using Toomer's edition of the Almagest ([1358]).

In his description of the transit circle in Chapter 1, Ptolemy tells us the following: "We made a bronze ring of the fitting size [what size exactly? – Auth.] … in order to use it as a transit circle, wherefore it was graded into 360 parts [degrees]; each of those were divided into as many parts as the instrument's size would allow [How many? – Auth.] … We have further discovered an easier method for conducting such measurements, having forged a stone or wooden wall [?! – Auth.] to be used instead of the rings" ([1358], pages 61 and 62).

What we see here obviously differs from the description of an actual device used for measurements by either Ptolemy alone, or himself and his team. How else could one explains such ambiguity as "fitting size", "as many parts as the instrument's size would allow", or "stone or wooden wall"? Really, was it stone or wooden?

Everything shall fall into place if we are to suppress the inner Scaligerite and realize that what we have in front of us isn't a report made by an observer, but rather an encyclopaedic textbook that explains a potential student or scientist the construction of various instruments; different methods of conducting research etc.

Consider the following passage from the Almagest, for instance: "Before [the reign of] Antoninus, when we conducted the most observations of immobile stars' positions" ([1358], page 328). Scaligerian astronomy reads the implication of Ptolemy claiming personal responsibility for the observations performed at the beginning of the reign of Antoninus Pius into this phrase. The Scaligerian dating of this emperor is 138-161 A.D. However, Ptolemy's phrase is rather vague and allows for different interpretations. Firstly, who are the "we" who conducted the observations? Ptolemy himself or his predecessors from the same scientific school? Furthermore, what exactly do "the most observations" refer to? The use of "we" etc has to be considered a distinctive of the Almagest's

author's literary style rather than an indication of his actual participation in the research; it is also possible that the hoaxer editors of the XVI-XVII century were intending to create an impression that what the work in question had been written to relate the research of a single person.

For example, let us take account of the words chosen by Ptolemy as the introduction to the Almagest star catalogue. It would be natural to expect the author/observer who had conducted the research in question himself to provide detailed descriptions of how his research was conducted, which stars were chosen for reference etc. Nothing of the kind. Ptolemy's text is very vague:

"Again, the very same instrument [the astrolabon – Auth.] permits to observe as many stars as humanly possible, including those of the sixth magnitude. We would always direct the first ring at the nearest bright star whose position in relation to the moon would already be calculated by then" ([1358], page 399).

This is followed by the description of the method used for stellar coordinate calculations when the longitude is measured by relatively bright stars, and the latitude in relevance to the astrolabon's ecliptic ring. This description is once again given in rather general terms, followed by the remarkable phrase:

"In order to represent the stars on a solid cosmosphere in accordance with the method described above, we have arranged the stars into a table with four columns" ([1358], page 340). Further on we find explanations of the indications used in the table. The "table" in question is the famous star catalogue. Therefore it turns out that Ptolemy's catalogue was created with the main purpose of using it for the creation of a cosmosphere.

Once again, this resembles a textbook – "in order to make a globe, one has to do this and that". A propos, Ptolemy makes another reference to Emperor Antoninus in his description of the "table", or catalogue: "In the second column one finds the longitudinal value deduced from the research [conducted by an anonymous scientist – Auth.] for the beginning of Antoninus' reign ([1358], page 340).

Once again, one needn't interpret these words of Ptolemy's as evidence of him having personally conducted observations in the epoch of Antoninus. This phrase can also be interpreted in the following manner: a late mediaeval observer rendered the catalogue to the values corresponding with the reign of Antoninus. By the way, the Almagest doesn't give us any datings for the reign of Antoninus. As we already know, the simplest action which can be undertaken in order to render a catalogue to any a priori known ancient epoch's ecliptic coordinates is the subtraction of a suitable constant value from the original longitudes. Furthermore, this explanation of ours is explicitly confirmed by the text of the Almagest! Ptolemy continues his thought right there: "The latitudinal values always remain immutable; as for the longitudinal values [contained in the Almagest catalogue – Auth.], they allow for easy longitudinal calculations for other moments of time as well, for which the distance between the current epoch and the necessary moment in time needs to be recalculated assuming the alteration speed equal to 1 degree every 100 years. The resulting value would then have to be subtracted from that of the current epoch in order to get a date in the past or added thereto for a future date" ([1358], page 340).

Thus, Ptolemy gives a perfectly clear explanation of how one is to shift the star catalogue in time subtracting the constant, which would make it "more ancient", or adding it for the opposite effect. Once again, this is very similar to a textbook that explains the technique of dating and re-dating star catalogues to students. This book may have also been a useful source of all the necessary guidelines in the XVI-XVII century A.D., especially considering as how the construction of a cosmosphere as related in the Almagest does not require absolute longitudinal values – namely, they are counted from an arbitrarily chosen immobile star. Ptolemy suggests to use Sirius for this purpose ([1358], page 405).

Apparently, the absolute values of ecliptic stellar latitudes simply have never been used in Scaligerian astronomy at all. Therefore, the longitudinal reference point could be chosen more or less arbitrarily. Copernicus, for instance, having copied the Almagest catalogue into Volume 6 of his own ***Revolutionibus Orbium Caelestium***, with some circumstantiation, counts latitudes off the γ star of the Aries constellation, which was located at the distance of 27° from the point of vernal equinox in the epoch of Copernicus.

One has to point out that the work of Copernicus, as history of astronomy is telling us, wasn't apparently "appreciated" until a century after his death, in Kepler's epoch, or the XVII century ([614], page 328). See Chapter 10 for more details. One can therefore ask the legitimate question of the exact date when the book attributed to Copernicus nowadays was written or edited. Could it have been the early XVII century and not the XVI – Kepler's epoch, in other words?

10. WHAT ECLIPTIC POINT DID PTOLEMY USE FOR LONGITUDINAL REFERENCE?

As we already know, the choice of the initial longitude count reference point influences the longitudinal precession dating of the catalogue to a substantial extent. Let us conduct a more in-depth study of the question which point of the ecliptic was used by Ptolemy for longitudinal calculations in his catalogue. It is traditionally assumed that he had used the vernal equinox point for this purpose, likewise many late mediaeval astronomers.

It turns out that the initial reference point issue as rendered by Ptolemy is far from simple, and cannot be resolved without controversy if we are to use nothing but the text of the Almagest for that end. Let us turn to the Almagest and provide the relevant quotations.

Ptolemy writes that "we shall be using the names of the Zodiac signs in order to refer to the correspondent twelve parts of the tilted circle which shall begin in the equinox and solstice points. The first twelfth part that begins at the vernal equinox point and whose direction is counter to that of the Universe shall be known as Aries, the next as Taurus …" (II:7 – [704], page 45). The signs in question are merely the arcs of the even Zodiac – not stellar longitudes. Furthermore, when Ptolemy tells us of the longitudes, he describes the second (longitudinal) column of his star catalogue as follows: "In the second column we find their [referring to the stars – Auth.] longitudinal positions educed from observations conducted in the beginning of Antoninus' reign. These positions are located inside the Zodiac signs; the beginning of each Zodiacal quadrant is determined by either a solstice or an equinox point, qv above" (VII:4, [1358], page 340).

Stellar longitudes in the Almagest are indeed indicated separately for every arc sign of the uniform zodiac and counted from the beginning of the respective arc sign. In other words, the stellar longitudes that we encounter in the Almagest should not be considered absolute and are counted off a single chosen point on the ecliptic. Instead of this, the relative longitudes contained by every respective arc sign of the uniform Zodiac are given, totalling to 12. It is also pointed out that one of the quadrants is oriented at the equinox point.

Therefore, the calculation of some absolute longitudinal value requires the addition of a certain integer number of degrees divisible by 30, or the size of a certain arc sign of the even Zodiac. The absolute ecliptic longitudes of the catalogue can only be deduced after this procedure, which is hardly all that complex in principle.

Let us illustrate by the following example. The North Star's longitude in the Almagest is given as Gem 0°10'. In order to calculate the absolute longitude value, we have to add an integer number of degrees to 0°10' that equals 60°, as contemporary tradition suggests. This is the number of degrees believed to correspond to the beginning of the Gem arc sign of the even Zodiac. We shall thus get the value of 60°10'. If we are to consider it to be the ecliptic longitude of the North Star as compared to the vernal equinox point, it shall correspond to the position the latter had occupied in the beginning of the new era.

One observes a perfectly similar situation with the remaining longitudes of the thousands of stars contained in the Almagest catalogue. The simplicity of the abovementioned calculations notwithstanding, one has to point out that this is our first opportunity to misinterpret the source data offered by the Almagest, namely, the fact that the integer degree values corresponding to zodiacal signs depend on the choice of the first arc sign of the even Zodiac, whose beginning coincides with the initial reference point – vernal equinox, or, possibly, some other point on the ecliptic. The alteration of the first Zodiac sign shall apparently alter the absolute degree values added. The vagueness of Ptolemy's phrase leaves plenty of space for interpretation.

As we shall find out, Ptolemy's description of the cosmosphere does not use the vernal equinox point for initial reference. He writes that "as it makes no sense to mark the solstice and equinox points on the globe's Zodiac (since stars maintain no constant distance to these points), we should select a number of fixed immutable reference points among the immobile stars. The brightest of those is the star in the mouth of Canis Major [Sirius, that is! – Auth.] … then for each or the remaining immobile stars in the catalogue [apart from Sirius – Auth.] we must mark its location [longitude – Auth.] rotating the graduated ring around the ecliptic pole – the point that we must mark on this ring's ecliptic is to be at the exact same distance from the reference point that we discovered (Sirius) as lays between the star in question and Sirius in the catalogue" ([1358], page 405).

Thus, Ptolemy gives us a direct reference to Sirius as to a convenient absolute beginning for the ecliptic longitude count. This is completely at odds with the consensual version which tells us that Ptolemy would definitely use the vernal equinox point for reference.

Furthermore, since the Almagest is an astronomical encyclopaedia of sorts, it may have been compiled from the works of various astronomers from different schools in its present form.

Therefore, different measurements principles may have been used for different parts of the Almagest – in particular, it is possible that the longitudinal reference point in the Almagest catalogue varies as taken for its different parts.

All of this indicates that the attempts to date Ptolemy's catalogue by longitudinal precession may lead to gravest errors, which is exactly what we see in some modern works on the history of astronomy, qv below.

Other contentious issues arise as well. The quotation mentioned above demonstrates that the creation of a cosmosphere requires circa 1000 astronomical operations – namely, the subtraction of the longitude of Sirius from the longitudes of a thousand other catalogue stars. However, the longitude of Sirius is expressed as a fraction in the Almagest catalogue, namely, 17°40' of Gemini. It is perfectly clear that the operation of subtracting this number from other longitudes a thousand times shall consume a great deal of labour. On the other hand, Ptolemy, who advocated using Sirius for reference, could well have chosen another very bright star – Arcturus. This is a star of great luminosity; most importantly, its longitude is expressed as an integer in the catalogue – namely, 27° of Virgo. Why would one perform a thousand operations with fractions when it would be a lot simpler and less time-consuming to perform the very same operations with degrees expressed as an integer?

One can make the natural presumption that a certain constant value was either added to, or subtracted from, the initial longitudes of the Almagest, which made the longitude of Sirius a fractional value instead of an integer. Therefore, this value had to comprise a certain amount of degrees and 40 minutes, since the longitude of Sirius in the modern version of the Almagest catalogue equals 17° 40'.

This is where we unexpectedly run into a good concurrence with the result of R. Newton ([614]). He proves that the longitudes contained in the catalogue were recalculated by someone, with an indefinite amount of degrees and 40 minutes added to the original longitudinal values, and bases his conclusion on altogether different considerations – those of a statistical nature. We deem such a good concurrence between two varying observations to be anything but random.

One has to make the following general observation, which bears no formal relation to astronomy, but might yet prove useful for our understanding of the role and the place of the Almagest. Modern literature on the history of astronomy gives one the impression that the Almagest chapters dealing with stars are a commentary of sorts, or an annex to the central document, which is the star catalogue. However, we are of a different opinion. The primary content of these chapters is Ptolemy's guidelines for the construction of the cosmosphere whereupon one was to point out the locations of the stars. The actual construction process, the paint one needs to use for the purpose etc are described with great detail; the catalogue itself is but a "reference table" for the construction of the cosmosphere.

It is quite possible that such cosmospheres were used for astrological or mystical purposes in the Middle Ages. The most curious fact is that the history of astronomy has many references to the construction of such cosmospheres – however, this "celestial globe

construction epoch" isn't even close to the beginning of the new era, it pertains to the Middle Ages. In particular, the first news of such globes that we have date from the epoch of Tycho Brahe, who constructed a cosmosphere himself ([395], page 127); this was considered an important task. We are told that "the large brass-plated cosmosphere, 149 centimetres in diameter, deserves to be mentioned separately. Its surface bore the representations of the Zodiacal belt, the equinoctial, and the positions of 1000 stars whose coordinates had been determined over the years of Tycho's observations. Tycho proudly confessed: "I believe that no other cosmosphere of this size, built with such accuracy and precision, has ever been made anywhere in the world". He also claimed that multitudes would come to Denmark specifically in order to admire the cosmosphere. Alas, this true wonder of science and art perished during a blaze in the second half of the XVIII century" ([395], page 127).

Thus, the respective Almagest chapters fit into the epoch of the XVI-XVII century perfectly well.

Furthermore, experts in history of astronomy suggest that even if the longitudes of the Almagest were recalculated, it was for a more recent epoch and never backwards. We are being convinced that the recalculation of old stellar longitudes for the current epoch was a common enough practice amongst mediaeval astronomers. References are also made to the "early mediaeval" catalogues predating Brahe. Mediaeval astronomers are supposed to have been "too lazy" to conduct new research. They would rather grab an "ancient" catalogue dating from times immemorial, alter all of its values by the factor of a single constant and come up with "modern star coordinates" as a result, subsequently using this ancient but so conveniently "updatable" catalogue in their own research.

One has to admit that this hypothesis looks rather strange. It is unlikely that each new generation of astronomers would contend itself with a mere "fabrication" of the kind of catalogue they needed via a shift of longitudes contained in some old and rather obsolete, catalogue. Every new epoch creates new and more advanced astronomical instruments. Therefore, it is most likely that the astronomers of every subsequent epoch would measure stellar coordinates again, with greater precision. Not only the longitudes were made more realistic, but the latitudes as well – those corrections may have varied from star to star. As a result, the astronomers of every new generation would compile a maximally accurate new catalogue for themselves (inasmuch as their instruments would allow, of course). This very method was used for scientific applications, such as navigation, as opposed to obsolete near-forgotten catalogues which contained many errors due to the imprecision of the primitive early instruments.

If anyone in the XVI-XVII sought to fabricate and introduce a falsified "ancient" history, the approach may have been radically different. Some recently-compiled star catalogue would be taken, and his longitudes shifted into "the past", or "the necessary historical epoch" – the early A.D. period, for instance. The operation was simple and did not consume much of the hoaxers' time. After that they would loudly claim having discovered "an extremely ancient star catalogue".

Let us reiterate that the simplest and fastest falsification method would employ a shift of all stellar longitudes by a single constant value. Apparently, this is how the "personal observations" of Ptolemy from the II century A.D. came into existence, as well as many other "observations" conducted by "early mediaeval astronomers". The hoaxers couldn't just open a modern catalogue, since they would be immediately caught, and preferred to use some catalogue dating to 100-200 years backwards, well-forgotten and out of print already.

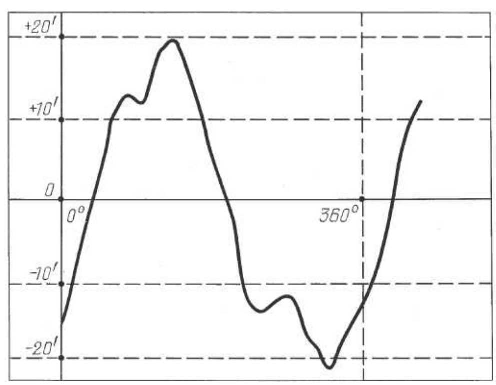


Fig. 2.27. The sinusoid of Peters in the latitudes of the Almagest star catalogue.

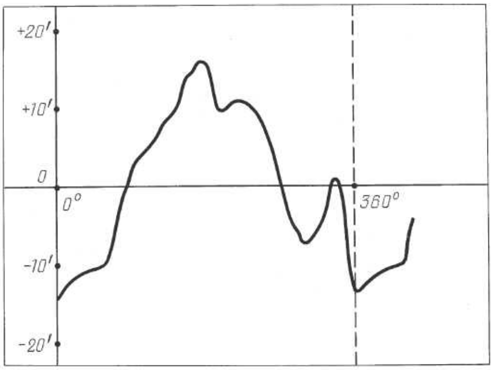


Fig. 2.28. The somewhat odd graph of average longitudinal discrepancy as a function of ecliptic longitude in the Almagest catalogue.

11. PETERS' SINUSOID IN ALMAGEST LATITUDES

Let us now consider the latitudes of the Almagest star catalogue. This is where we immediately discover a most peculiar effect that defies explanation in the paradigm of earlier Almagest studies. We shall be referring to this effect as to the "Peters' sine curve". The matter at hand is as follows: Peters analyses the average error distribution in the Almagest as a longitudinal function. For this purpose he calculates the positions of the modern sky's Zodiacal stars for 100 A.D., or the alleged epoch of the Almagest creation. Then Peters calculates the latitudinal discrepancy of $\Delta_i = B_i - b_i$. Thus, B_i is the latitudinal value of star i from the Almagest, and b_i – the meaning of its latitude for 100 A.D. as per Peters. Therefore, the Δ_i value demonstrates "Ptolemy's error" in the determination of star i's latitude, made under the assumption that the Almagest was created around 100 A.D. Peters proceeds with the division of the ecliptic into 10 degree intervals and then calculates the average latitudinal discrepancy value for all the Almagest stars that wind up in this interval, which naturally varies from one interval to another.

A special graph has been built as a result, one that demonstrates how the average latitudinal discrepancy manifests along the ecliptic. Points of the ecliptic can be characterized by ecliptic longitude; the graph built as a result will represent latitudinal discrepancy as a longitudinal function. The sine curve of Peters can be seen in fig. 2.27. It is very much like a sine curve with the amplitude of circa 20'. One could choose a sinusoidal curve considered best in its class for the approximation of the curve in fig. 2.27. The resulting sine curve was named after Peters.

The appearance of Peters' sinusoid is very hard to explain within the framework of the modern ideas of the Almagest. At any rate, we have found no reasonable explanation of this distinctly periodical phenomenon in any kind of literature.

One has to point out that [1339] contains no details related to the calculation of this curve by Peters. In particular, we learn nothing of the actual Zodiacal stars he used for calculations. Therefore, in order to confirm the actual existence of the effect and study it we had to recalculate the curve in question for all the Zodiacal stars with the aid of a computer. Our results, as well as their implications and related commentary can be found in the chapters to follow. Let us however jump ahead for a moment and divulge to the reader that we find a perfect explanation for this strange sine.

NB. Apart from the latitudes, Peters also studied the longitudes of the Almagest catalogue ([1339]). He counted the average latitudinal discrepancy for 10-degree sectors and came up with the graph that we see in fig. 2.28. The curve represents the behaviour of the average longitudinal discrepancy as a function of ecliptic longitude. It is remarkable that the graph is drastically different from the one with the Almagest latitudes. The longitudinal graph is by no means sinusoidal; its amplitude is smaller; besides, and it has two rather distinct local maxima. It is possible that this oddly irregular nature of the "longitudinal" curve is a result of the mysterious ecliptic longitude recalculation as discovered by R. Newton in [614] (see section 8). As it has been pointed out, the longitudes of the Almagest catalogue are by no means a reliable source of information; therefore, we have no reasons to study the resulting graph more attentively. Such analysis would only make sense if the longitudinal recalculation mechanisms, which must have been used by later astronomers (possibly of the XVI-XVII century), could be reconstructed, which we believe to be a very difficult task at this point.

CHAPTER 3

Unsuccessful attempts of dating the Almagest. Reasons for failure. Our new approach and a brief account of our results

1. THE ATTEMPT TO DATE THE ALMAGEST BY A COMPARISON TO THE CALCULATED CATALOGUES REFLECTING THE MOTION OF THE FASTEST STARS

1.1. The comparison of the Almagest catalogue to the calculated catalogues

In Chapter 1 we refer to the algorithm of recalculating the modern positions of celestial objects backwards "into the past". Thus, what we have at our disposal presently is the Almagest catalogue compiled in ecliptic coordinates in some unknown epoch t_A, and the set $\{K(t)\}$ of the calculated star catalogues. They reflect the real situation on the celestial sphere that we computed for a given time moment t. Let us try and determine the desired value of the date t_A, or the epoch when the Almagest catalogue was compiled. We shall begin with the following idea which appears quite simple and try to compare the positions of individual stars in the Almagest to their positions in the calculated catalogues $K(t)$; after that we shall try to select such a value t^* for the evaluation of the date t_A that it would make the Almagest data correspond to those contained in the catalogue $K(t^*)$ in the best way possible.

We shall refrain from going into detail about the quality criteria of such correspondence and merely define the meaning of "comparing the Almagest to catalogue $K(t)$ with a given t value". What this implies is selecting the same coordinates from catalogue $K(t)$ and the Almagest. The comparison in question makes year t serve for the alleged dating of the observations that the Almagest catalogue is based upon. Therefore, in order to compare the coordinates of the stars in the Almagest with their coordinates in the calculated catalogue, one has to set the Almagest ecliptic into the same plane as the ecliptic of the calculated catalogue $K(t)$.

However, such a superimposition shall allow for nothing but latitudinal comparison, whereas we also need to compare stellar longitudes. In other words, we shall have to impose the Almagest star atlas over the real one for epoch t, supposing t to be the real time when the Almagest author performed his observations. This requires marking the vernal equinox point for epoch t on the Almagest ecliptic. This point is to be selected in such a way that the average longitude error for the Zodiacal stars of the Almagest would equal zero. Bear in mind that we are using the table of traditional identifications of the Almagest stars with the modern star chart as given in [1339] for our comparison with the longitude of the relevant stars

from the catalogue $K(t)$. It isn't that formidable a task to select such an equinox point. As it is known (qv in [1040] and [1339]) that t = 18.4, or corresponds to the Aries arc sign on the Almagest ecliptic for 60 A.D., shifting with the speed of roughly 49.8" for each year t – the precession speed, that is.

We cannot quite evade errors in our choice of the vernal equinox point on the Almagest ecliptic with the method indicated above, which is optimal statistically. Its complete evasion would be achieved if we merely compared stellar latitudes without taking the longitudes into account whatsoever. This is what we shall do below, in Chapters 3-5. We shall analyze the latitudes and the longitudes separately. The considerations given in the current section are of a preliminary character.

1.2. The attempt of dating the Almagest catalogue by proper movements of individual stars

Let us choose nine of the fastest stars for comparison, indicated in the Almagest according to [1339]. These are the stars, whose proper movement speed exceeds 1" per year. Their list is as follows:

α Cent (969) – 4.08" per year,
o^2 Eri (779) – 3.68" per year,
α Boo (110) = Arcturus – 2.28" per year,
τ Cet (732) – 1.92" per year,
α CMa (818) = Sirius – 1.33" per year,
γ Ser (265) – 1.32" per year
ι Per (196) – 1.27" per year,
α CMi (848) = Procyon – 1.25" per year,
η Cas (180) – 1.22" per year.

All these stars are contained in the Almagest, according to traditional identifications ([1339]). The numbers given to them by Bailey in the serial numeration of the Almagest are in parentheses. Let us represent each of these Almagest stars as a circle without any shading, see figs. 3.1-3.8. We decided to omit α Centauri, since the coordinates of this star which lays far to the south are given in the Almagest with the gigantic 8-degree error. In fig. 3.4, apart from the Almagest star 779, one can also see the neighbouring stars 778 and 780 and the trajectories of real stars

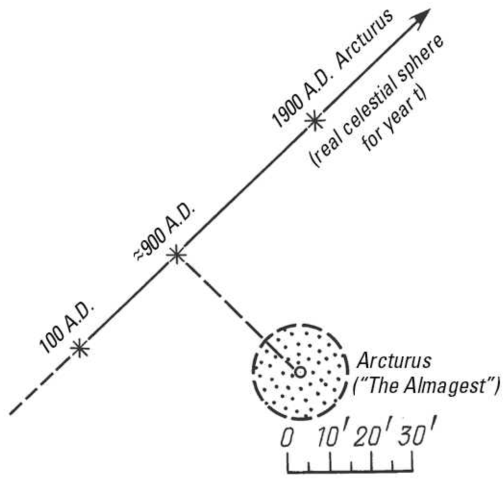


Fig. 3.1. The motion of the real Arcturus as compared to its position specified in the Almagest. This graph doesn't account for the systematic error made by Ptolemy or compensate it.

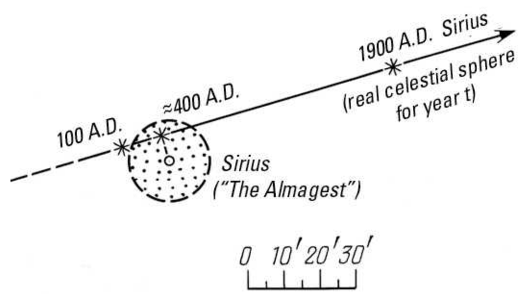


Fig. 3.2. The motion of the real Sirius as compared to its position specified in the Almagest. This graph doesn't account for the systematic error made by Ptolemy or compensate it.

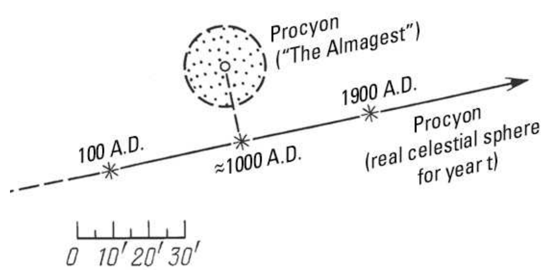


Fig. 3.3. The motion of the real Procyon as compared to its position specified in the Almagest. This graph doesn't account for the systematic error made by Ptolemy or compensate it.

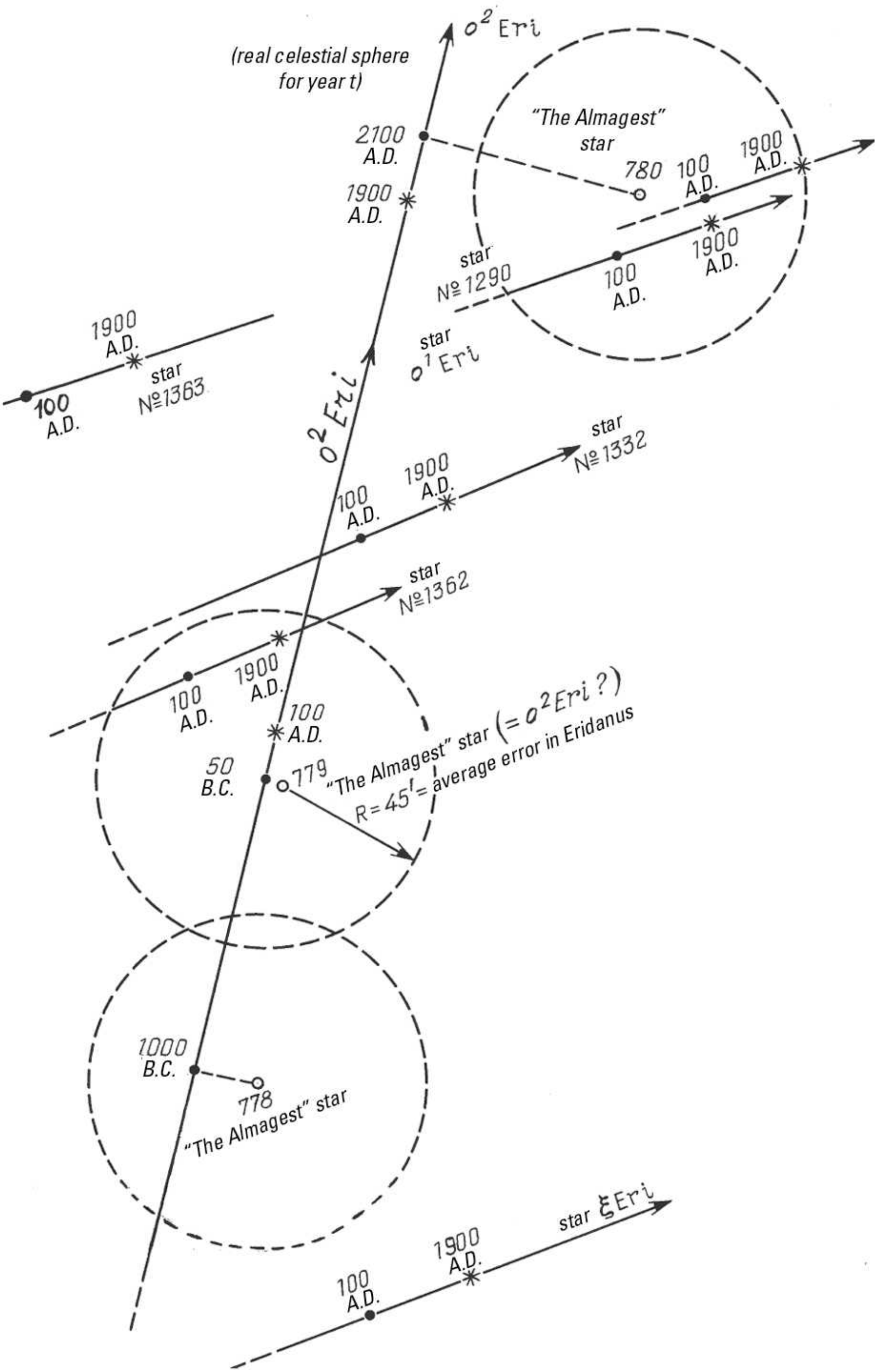


Fig. 3.4. The motion of the real stars o^2 Eri and ξ Eri as compared to the Almagest data. This graph doesn't account for the systematic error made by Ptolemy or compensate it. The numbers of the stars are given in accordance to a modern catalogue ([1197]).

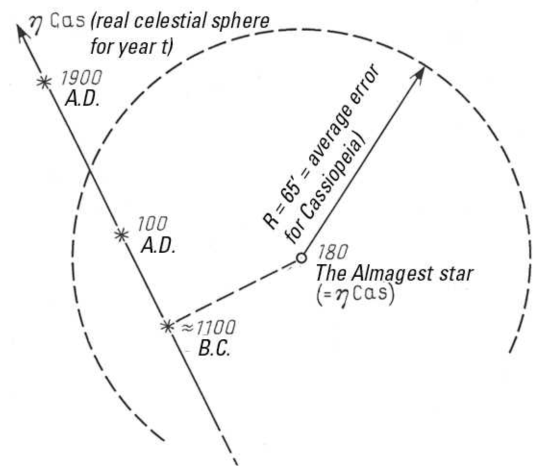


Fig. 3.5. The motion of the real star η Cas as compared to its position specified in the Almagest. This graph doesn't account for the systematic error made by Ptolemy or compensate it.

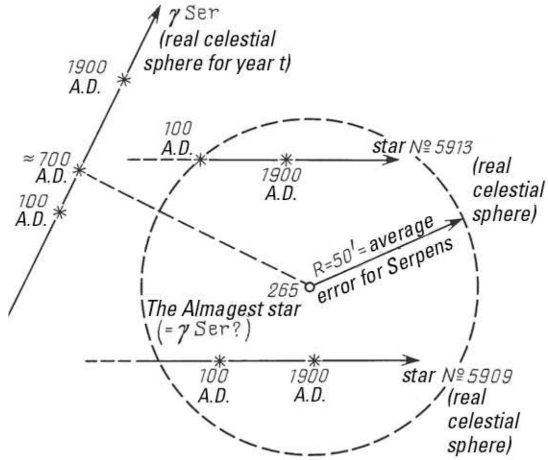


Fig. 3.8. The motion of the real star γ Ser as compared to its position specified in the Almagest. This graph doesn't account for the systematic error made by Ptolemy or compensate it. Star numbers are given according to a modern catalogue ([1197]).

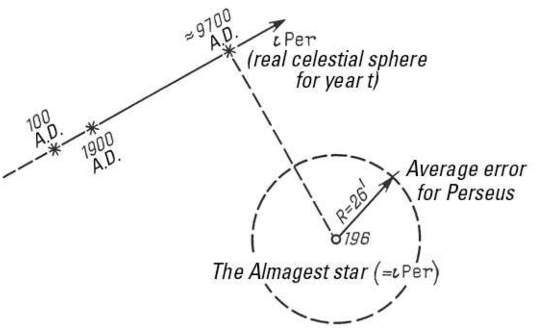


Fig. 3.6. The motion of the real star ι Per as compared to its position specified in the Almagest. This graph doesn't account for the systematic error made by Ptolemy or compensate it.

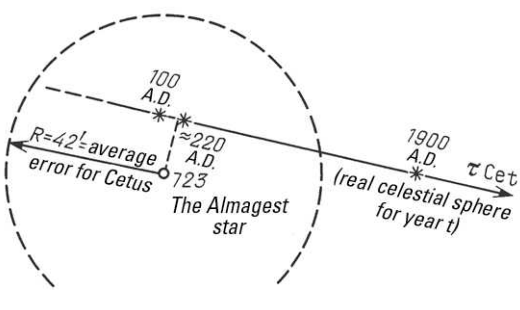


Fig. 3.7. The motion of the real star τ Cet as compared to its position specified in the Almagest. This graph doesn't account for the systematic error made by Ptolemy or compensate it.

numbered 1332, 1362 and 1363 from the catalogue ([1197]). Thus, we have eight stars left.

Let us now regard the small neighbouring areas of each of these eight stars in Ptolemy's star atlas. We shall be using these star coordinates as given in the Almagest. Each of these areas contains one of the eight fast stars listed above. Furthermore, we share the opinion [1339] that Ptolemy did in fact observe all of these eight stars, and that they are really present in his catalogue.

Now let us superimpose the star atlas compiled from the calculated catalogue $K(t)$ which reflects the state of the real celestial sphere for epoch t, over Ptolemy's star atlas compiled from the Almagest; we shall be using the method described above, and perform this procedure for every t moment. We shall now draw our eight fast stars among the stars of the Almagest.

The method of imposing the calculated atlas $K(t)$ over Ptolemy's atlas depends on the choice of epoch t. Moreover, each of the eight fast stars changes its position in relation to the other stars from the calculated catalogue $K(t)$ with an alteration of t. Thus, the way these stars shall be represented on Ptolemy's atlas shall also depend on the time t. We will come up with eight new trajectories on Ptolemy's atlas correspon-

ding to the shift of our eight fast stars after the alteration of t. These trajectories can be seen in figs. 3.1-3.8. Let us emphasize that we are not yet taking into account the systematic error in stellar locations that we discovered the Almagest's compiler to have made. We shall relate the story of this error in detail below.

What are the t moments that we are considering now when the real fast stars are the closest to how they were represented on Ptolemy's atlas?

Generally speaking, these moments vary from star to star. For the eight stars listed above we shall mark them as $t_1, t_2, \ldots, t_8$. If it turns out that all the values of t_i $(1 \leq i \leq 8)$, or a considerable part of them at the very least, turn out to be close to each other as well as some averaged value of t^*, it shall be strong argumentation in favour of the theory that the true time of the Almagest's author's observations is close to t^*.

However, this doesn't appear to happen. Indeed, the values t_i are chaotically scattered across the time interval $-70 \leq t \leq 30$), or 1000 B.C. – 9000 A.D.! The range is just too great. Let us compile the results into table 3.1 to make them more illustrative. The fact that the individual datings t_i are spread across this great a range is hardly surprising. The matter is that each of the eight stars under comparison is represented in the Almagest with a certain error which is rather serious.

The idea of the possible rate of this error for an individual star can be obtained from the average arc declination in the constellation that the star in question is part of. Under the arc declination we understand the gap between the star's position in the Almagest and its true calculated position. Strictly speaking, the indicated average error depends on the alleged dating of the Almagest – due to the proper movements of stars, for instance. However, the stars on the celestial sphere are almost immobile for the most part. It appears that the rate of this average error is only marginally dependent on the epoch that the stellar coordinates are calculated for. The precision level that is of interest to us allows to disregard this dependency.

In order to calculate the average error rate, we have used the comparison table that contains the star positions in the Almagest together with their real positions for 130 B.C. that we encounter in the work of Peters and Knobel ([1339]) – calculated for the epoch of the "ancient" Hipparchus, that is. Let us draw the "precision circle" around the point that represents a fast star in the Almagest whose radius will equal the average error rate for the constellation that contains the star in question, qv in figs. 3.4-3.8. The projection of this circle over the trajectory of the calculated star that reflects the movement of a real fast star across the celestial sphere shall give us an idea of the possible error rate pertinent to the individual dating t_i by the star in question as compared to the real date of the catalogue's compilation. Let us also point out that the individual star measurement errors that we know nothing about can differ from the average error rate drastically. The radius of the "precision circle" for Arcturus, Procyon, Sirius and other named stars was chosen as equalling 10', or the Almagest catalogue scale grading value. See figs. 3.1-3.3.

Table 3.1. Approximate datings of the Almagest catalogue by the proper movements of eight fastest stars observable with the naked eye.

Star name	*Dating closest to the star observation time in the Almagest*	*Minimal distance to the star of the Almagest*
Arcturus = α Boo	900 A.D.	40'
Sirius = α CMa	400 A.D.	10'
Procyon = α CMi	1000 A.D.	20'
o^2 Eri	50 A.D.	5'
η Cas	1100 B.C.	40'
ι Per	9700 A.D.	70'
τ Cet	220 A.D.	15'
γ Ser	700 A.D.	80'

1.3. Why the dating of the Almagest by individual star movements gives us no reliable result

The question that inevitably arises in this regard is whether the results achieved with the use of one or several of the eight stars listed above can be trusted more? In that case, this is the star which we must use for the purpose of evaluating and dating Ptolemy's re-

search, rejecting the datings based on all the other stars as not reliable enough. It is natural to use the stars whose coordinates are the most correct in the Almagest. But how does one choose them?

In some works it was suggested to evaluate the precision of Ptolemy's measurements for each of the stars in question basing our judgement on the calculated arc discrepancy for a given star – using the last column of the cited table, in other words. The implication would be that the coordinates of the star o^2 Eri were measured by Ptolemy with the precision rate of 5', for instance, and those of Arcturus – with the precision rate of 40'. This is exactly what the authors of [273] Y. N. Yefremov and Y. D. Pavlovskaya had done. They had tried to date the Almagest by proper movements and worked with the same list of 9 stars in particular. This approach would yield a dating which would be close to the Scaligerian – 50 B.C., qv in table 3.1. The evaluation of the possibility that this dating is erroneous is a separate issue which we shall consider below. To jump ahead very briefly, we shall merely state that the possible error rate of Yefremov and Pavlovskaya's method was estimated perfectly unrealistically in [273].

This approach instantly leads us to the following set of questions. The first one concerns the rather absurd situation in which all three stars of the first magnitude out of nine, namely, Arcturus, Sirius and Procyon (and ones that have names of their own in the catalogue at that) were measured by Ptolemy very roughly, with error rates approximating an entire degree. Yet the dim and poorly-visible star o^2 Eri was for some reason measured with the utmost precision, the discrepancy equalling a mere 5'! Let us explain that the magnitude of this star according to modern measurements equals a mere 4.5, which means it is very dim.

All of this is most bizarre indeed. Such bright and famous stars as Arcturus, Procyon, Regulus and Spica must have served Ptolemy in his research as control points, or, at the very least, their coordinates were measured with the utmost care and precision. Their exceptional importance to ancient astronomy is reflected in the very fact that they have own names in the Almagest. There are even special sections of the Almagest concerned with the measurements of some of them. Therefore the precision of their coordinate calculation must have been very high indeed (see [968], for instance). At the same time, there is nothing very noticeable about the star o^2 Eri. It cannot be distinguished from the stars surrounding it, them being just as dim.

Furthermore, the star traditionally associated with o^2 Eri is merely described as an "average star" in the Almagest. Therefore, we would be justified to ask another perplexed question after taking a look at fig. 3.4. Why would the Almagest star #779 possibly be identified as o^2 Eri? It is perfectly clear that this is a conclusion one can only arrive at in case when the coordinates of the real star o^2 Eri and the star #779 from the Almagest correlate with each other optimally – better than those of o^2 Eri and the star #778, for instance. However, due to the significant proper motion velocity of o^2 Eri this clearly implies that its identification as any star of the Almagest is greatly dependent on the time we date the Almagest to.

For instance, if we knew that the Almagest was written in 1000 B.C., we could identify o^2 Eri with the Almagest star #778, and then successfully "date" the Almagest to the very same year 1000 B.C. judging by the minimal possible distance between o^2 Eri and the star #778, which would serve as "sound proof" of our a priori dating.

A propos, this identification makes the concurrence between the coordinates of o^2 Eri and the Almagest even better than the traditional version, as one can plainly see in fig. 3.4. If we assume that the Almagest was written in 1500 A.D., or the XVI century, for instance, we might identify the star o^2 Eri as the Almagest star #780 and date it to the late Middle Ages, or even a "future epoch", qv in fig. 3.4.

It is clear that ruminations of this sort lead to a vicious circle. The dating of the observations based on proper star motion requires a reliable identification of said star as one contained in the Almagest, all of this independently from its presumed dating.

However, even if we are to disregard o^2 Eri, we still cannot use the remaining eight fast stars for a secure dating, even now. The dating dispersion is too great for all the different stars. Even the datings made by the stars of the first magnitude out of the eight stars under study (Arcturus, Procyon and Sirius) are scattered over the 600-year interval between 400 A.D. and 1000 A.D., qv in table 3.1.

Furthermore, one needn't forget that the datings deduced in such a manner (900 A.D. for Arcturus) only represent the moments when the real positions of the stars are the closest to those given in the Almagest catalogue.

One also needs to specify the time intervals surrounding these datings for which the deviation values would fall into a range conforming to precision requirements.

The gravity of the situation is all the greater that if we are to use average values for the evaluation of just how precisely this star or the other was measured in the Almagest, we shall be making a certain error a priori, knowing nothing of the individual errors made in the measurement of the stars in question by Ptolemy.

Let us formulate the corollaries:

1. Before one can use the coordinates of a separate star as given in the Almagest for the purposes of dating, one needs to make sure that identifying the star in question as a star observed upon the modern celestial sphere does not depend on a presumed dating of the Almagest, which would lead us to a vicious circle once again.

2. Even for the fastest of stars, the shifts made due to proper motions are small enough inasmuch as the span of the historical period is concerned (see figs. 3.1-3.8). Therefore, a dating would require a selection of stars whose positions in the Almagest would be measured with enough precision. A star than only shifts by 2" in a year will shift by a mere 3.3' over the period of a century.

Therefore, if we want to use an individual fast star for the dating of the Almagest with the precision range of circa 300 years, we must be certain that the precision of this star's position as given in the Almagest does not exceed the discrepancy rate of 10'. According to the estimations of researchers, the real precision of the Almagest is a lot lower in general ([1339]).

The stars whose coordinate precision discrepancy rate exceeds 20' are all but void of utility for us. The dating interval is 1200 years minimum if we are to use them for dating purposes.

This issue is considered in more detail below (see Chapters 5 and 6).

2. AN ATTEMPT OF DATING THE ALMAGEST CATALOGUE BY THE AGGREGATE OF FAST AND NAMED STARS AS COMPARED TO THE CALCULATED CATALOGUES

2.1. The criteria one is to adhere to in one's choice of the stars for the purpose of dating

In section 1 we demonstrate that the comparison of the Almagest with the calculated catalogues $K(t)$ by the eight of the fastest stars doesn't allow us to indicate a t^* value that makes the Almagest correlate with the catalogue $K(t^*)$ in the best possible manner. For each star the value of $t^* = t_i^*$ is unique and differs from the values of other stars significantly. The scatter range for different stars equals several millennia. Therefore, the approach as described above is too rough, and gives us no substantial result.

However, it might turn out that once we make the sample include a lot more stars than eight, we shall come up with such a set of individual datings $\{t_i^*\}$ whose larger part will fall into a rather short time interval. At the end of the day, even an interval of circa 500 years would suffice; in this case we would be given some sort of opportunity to obtain the information concerning the real date of Ptolemy's research (t_A). Apart from that, making the sample more inclusive might enable us the use of mathematical statistics methods for the estimation of the t_A value.

What other stars should one include in the sample? It is clear that only the fast and relatively well-measured stars fit the purposes of dating. These two criteria – proper motion velocity and the record precision in the Almagest, complement each other in general, since the faster the star, the greater the error we can make for its coordinate in the Almagest without affecting the dating by the star in question.

These considerations lead us to the choice of the following stars for the comparison of the Almagest with the calculated catalogues $K(t)$.

1) The stars which move fast enough. Let us choose 0.5" as the annual speed threshold pertaining to a single equatorial coordinate at least α_{1900} and δ_{1900} for the epoch of 1900 A.D., qv in table 1.1).

2) "Famous" or named stars, or the stars which have old names of their own (see table P1.2 in Annex 1).

Naturally, named stars may have received their names already after the creation of the Almagest, which appears to be true for many stars. However, firstly, the stars' names are unlikely to have been forgotten with age, although they may indeed have altered. In other words, named stars of Ptolemy's epoch remain such until the present day. Secondly, the fact that a given star received a name of its own tells us that it had been charged with a particular significance in old astronomy. It would therefore be self-implied that Ptolemy had paid more attention to named stars than to others, which would be manifest in their more precise measurement especially.

Let us choose the interval of $0 \le t \le 30$ as the a priori time interval for our research (1100 B.C. to 1900 A.D., that is). Bear in mind that the letter t refers to the time counted backwards from 1900 A.D. in centuries.

2.2. The "proximity interval" system as applied to certain fast or named stars

Let us merge the lists of fast and named stars from tables P1.1 and P1.2 (from Annex 1) in order to study them together. We shall choose those stars from the multitude that one finds in the Almagest according to [1339]. The resulting list consists of circa 80 stars. Let us calculate the trajectory of every star from this list in the Almagest coordinate grid as we have done in section 1 for the eight fastest stars.

Be sure to mark that for this purpose we have fixed a certain t value as the presumed dating and calculated the location of each star for the epoch t in the ecliptic coordinates of the epoch. This position can be represented as a point on Ptolemy's star atlas – that is, an atlas built from the Almagest catalogue under the assumption that it was compiled in epoch t. Changing the value of the alleged dating t within the range of the historical interval under study, we are making the star, or point, move along Ptolemy's atlas across the stars of the Almagest. As time t alters, the calculated star i moves across the stars of the Almagest (proper star motion as well as the slight shifts of the ecliptic that take place with the course of time). The distance between the calculated point or star and the Almagest star that this star becomes identified as also changes in its turn. The identifications

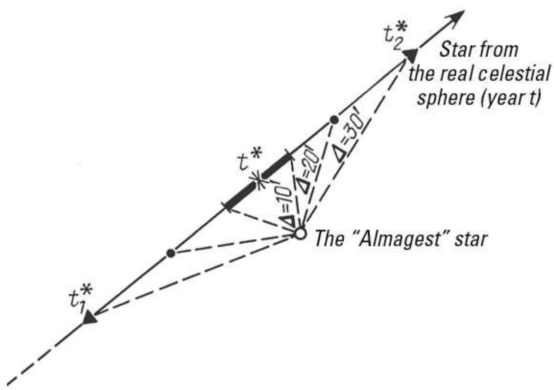


Fig. 3.9. The motion of a real star near the position specified for it in the Almagest.

correspond to [1339]. The distances on the celestial sphere would be measured on the geodetic arc that connects the stars. Bear in mind that geodesic lines on a sphere, or the line of the shortest local lengths, are the arcs of large circumferences or flat cross-sections that go through the centre of the sphere. Such distances on spheres are called arc distances; we shall simply refer to them as "distances".

Let the distance between the stars be minimal for the moment $t^* = t_i$. We have dubbed moment t^* the "individual dating" by a given star in section 1. When t deviates from the t^* value into either direction, the distance between the real calculated star and its representation in the Almagest begins to grow.

Let us conside the dating interval $[t^*_1, t^*_2] = [t_{i1}, t_{i2}]$ where the distance in question does not exceed 30' correspond to every star with the number i from the list. This interval can actually be empty, which shall be the case if the distance between the calculated star and the respective star from the Almagest exceeds 30' for moment t. The centre of the interval shall be defined by value t^*. See fig. 3.9.

The 30' limit for the arc distance between the Almagest star and the corresponding calculated star was chosen with the goal of having most of the Almagest stars stay within it. Indeed, if we are to consider the average square error rate in the arc distance for the Almagest stars to exceed 40' (which concurs with the research conducted in [1339] and [614]), more than half the stars in the Almagest must be represented with the precision rate of circa 30'. We are

basing this on the hypotheses of normal error distribution and of error independence as taken for individual stars. Due to the approximate nature of our narrative, possible discrepancies that these presumptions might lead to do not affect our corollaries.

The set of the intervals that we calculate in this manner, or the "proximity intervals", can be seen in fig. 3.10. What we see here is the time axis beginning with $t = 0$, or 1900 A.D., and ending with $t = 30$, or 1100 B.C. Each interval has a centre defined by the optimal dating t_i for a given star. We also mark the points for which the distance between the "Almagest star", or the position given in the Almagest, and the calculated star, equals 10' and 20' (see fig. 3.9). Lines representing distances under 10' are heavier as seen in fig. 3.10. The ends of the intervals are marked with pointers where they stay within the graph.

Many of the stars in our list of fast and named stars do not have a corresponding interval in fig. 3.10. This should imply the interval in question to be:

1) Altogether nonexistent (in cases when the distance between the Almagest star and the calculated star remains greater than 30' in all cases).

2) Failing to cross the a priori interval $0 \le t \le 30$ and located beyond the area of the graph.

3) Covering the a priori interval completely.

In the latter case, the coordinates of the star must have been measured with enough precision for the 30' interval; however, one cannot date the observations in the interval between 1100 B.C. and 1900 A.D. by the positions of such stars since their movement is too slow.

Let us give Bailey's numbers of the Almagest stars for which the 30-minute proximity intervals cover the entire interval $0 \le t \le 30$ given a priory (see [1339] and [1024]). These are the stars with numbers 35, 36, 163, 197, 222, 316, 318, 375 and 768.

Only partial intervals are given for many stars. This happens when part of the interval is located outside the a priori interval of $0 \le t \le 30$ and thus fails to be represented in fig. 3.10.

Next to each interval one sees the number of the corresponding Almagest star in Bailey's numeration. The name of the modern star identified as the current Almagest star, as well as its own special name, in case of its existence, is given next to the equal sign.

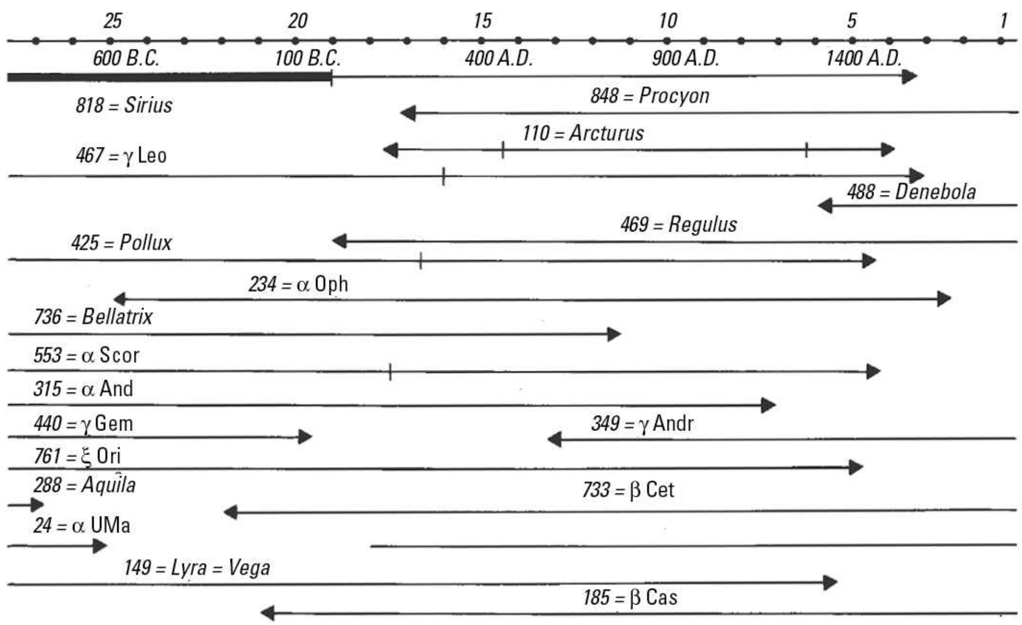


Fig. 3.10. Intervals of maximum proximity between visibly mobile fast or named stars with their corresponding positions as specified in the Almagest.

In fig. 3.12 we reproduce a similar graph for latitudes; the moment $t = 18$ is represented with a dotted line and stands for the Scaligerian dating of the Almagest (around 100 A.D.).

2.3. Dating the Almagest with the suggested method utilizing arc distances of individual stars is an impossibility

Fig. 3.10 tells us very explicitly that time values t which would belong to all the "maximal proximity" intervals simultaneously do not exist. Let us raise the precision threshold starting with the 30' value as chosen above, in order to obtain the desired values of t. The intervals as seen in fig. 3.10 shall grow respectively, with pointers indicating the direction of growth. At some moment, all the intervals shall begin to intersect. Let us see what value of t and precision threshold value it should take for this intersection to occur the first time. It turns out that it takes place with $t \approx 12$, or around 700 A.D., with the precision threshold of about 60', or one degree. If we keep raising the precision threshold, the intersection interval will grow in both directions from the point $t = 12$.

However, we cannot regard point $t = 12$, or 700 A.D., as a reliable enough estimate of the date when the author of the Almagest catalogue carried out his observations since the intersection of all "maximal proximity" intervals in fig. 3.10 only takes place at the precision threshold of 1 degree, which implies the existence of very poorly-measured Almagest stars in this set. The error in the estimate of their position contained in the Almagest equals one degree at the very least.

Furthermore, if we are to estimate the precision of stellar coordinates from below with the aid of the selective average square arc error in the optimal point $t = 12$, we shall have to raise the acceptable error rate value (or the precision threshold) excessively (over 2 degrees). However, such a value of the precision threshold shall make the acceptable "maximal proximity" interval intersection cover the entire period between 500 B.C. and the present (see fig. 3.10). Such a corollary is of zero scientific interest, since it is perfectly understandable that the Almagest was created somewhere in this great time period.

Moreover, the very dating of 700 A.D. is rather un-

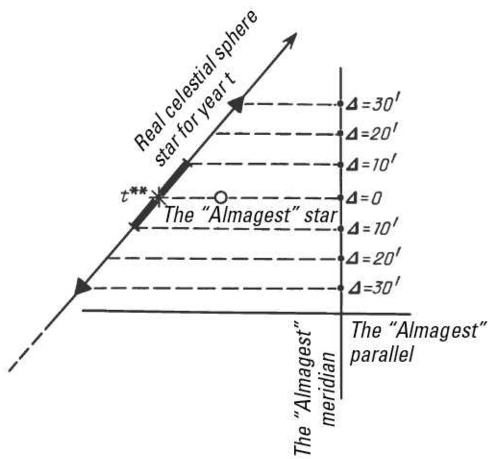


Fig. 3.11. Latitudinal discrepancy for the real calculated star and its position as specified in the Almagest.

stable in the following sense. An alteration in the compound of the stars under study (which is obviously chosen rather arbitrarily) can shift the dating moment rather significantly.

It is clear that such a situation makes all claims of a reliable deduction of the Almagest catalogue compilation date quite void.

2.4. Dating the Almagest catalogue with the suggested method based on latitudinal discrepancies of individual stars also proves impossible

Let us consider another method of calculating maximal proximity intervals for the Almagest stars from our list of fast and named stars. This method is similar to the one described above, the difference being that this time the distance between the Almagest star and the corresponding calculated star is composed of the latitudinal discrepancy and not arc segments. By latitudinal discrepancy we mean the projection length of the interval that connects these two stars over the Almagest coordinate grid meridian (see fig. 3.11). The choice of a latitudinal discrepancy (as opposed to longitudinal, for instance) was made out of the following considerations: firstly, it is well known that the Almagest star latitudes are more precise than the longitudes (qv in [1339], for instance, as well as Chapter 2 of the present book). Secondly, the latitu-

dinal discrepancy does not depend on how we position the Almagest in relation to the calculated catalogue $K(t)$ in terms of longitudes, qv in Chapter 1. Thus, we shall manage to evade making additional errors which may result from such juxtaposition as well as the possible arbitrary choice of the initial longitudinal reference point (see Chapter 1).

In fig. 3.12 we see the resulting maximal proximity interval set for the case when the latitudinal discrepancy represents the distance. Once again, the proximity intervals which cover the entire interval of $0 \le t \le 30$, or 1100 B.C. to 1900 A.D., are absent from the graph. The Almagest numbers of the stars whose 30-minute latitudinal proximity intervals cover the interval $0 \le t \le 30$ completely are as follows: 1, 35, 36, 78, 111, 149, 163, 189, 222, 234, 287, 288, 315, 316, 318, 349, 375, 393, 410, 411, 424, 467, 469, 510, 713, 733, 760, 761, 768, 812 and 818.

A comparison of fig. 3.12 and fig. 3.10 demonstrates that the longitudes of the Almagest stars under study are indeed a lot more precise than their positions on the celestial sphere defined by both latitude and longitude. This is exactly why one sees more intervals in fig. 3.12 than in fig. 3.10, which represent a greater amount of stars.

Maximal proximity intervals for all the stars in fig. 3.12 apart from two stars in Centaur (935 = 2*g* Cent and 940 = 5θ Cent) also begin to intersect at the level of $t = 12$, or approximately 700 A.D., latitudinal precision threshold equalling 40'. This is somewhat better than the 60' value that we got in the previous case, but still nowhere near precise enough. We are brought to the dating of roughly 700 A.D. once again, but, as in the above case, we cannot consider this result reliable due to the considerations related above; therefore, this method of dating the catalogue gives us no tangible results.

In general, regardless of the fact that the transition from the arc discrepancy to the latitudinal discrepancy helps us rectify the errors of the Almagest to some extent and therefore allows for more precise statistical corollaries, the resulting intervals of possible datings remain too great. They cover the entire period of $4 \le t \le 20$, or 100 B.C. – 1500 A.D. Such intervals give us no useful information in re the date of Ptolemy's observations.

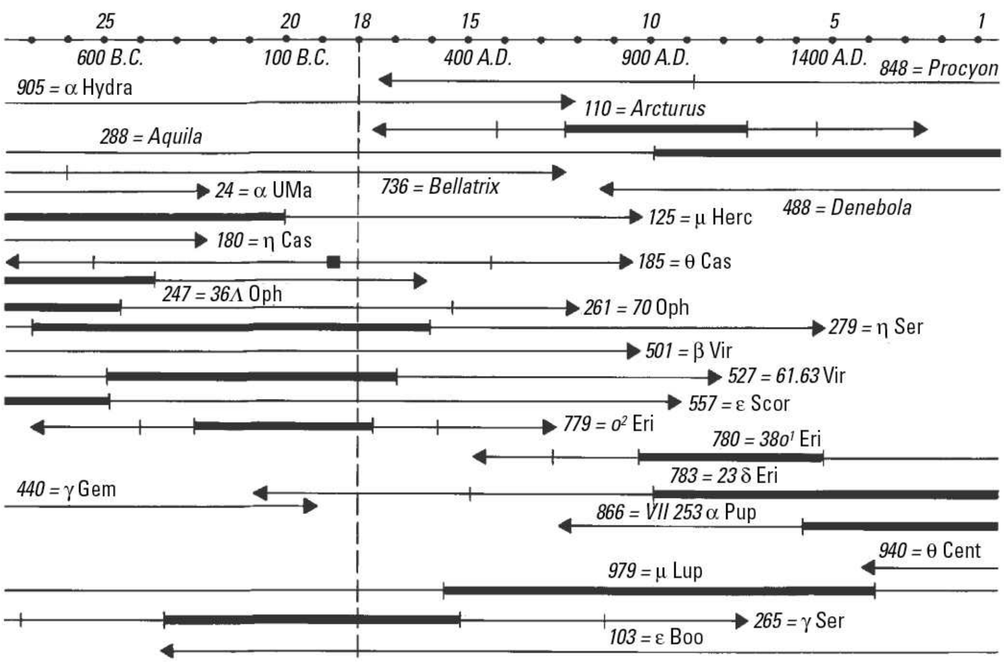


Fig. 3.12. Intervals of "maximum latitudinal proximity" between the visibly mobile real fast stars and named stars and the corresponding "Almagest stars".

3. THE ATTEMPT TO DATE THE ALMAGEST CATALOGUE BY THE MOTION OF INDIVIDUAL STARS AS COMPARED TO THE OBJECTS IN THEIR IMMEDIATE VICINITY

3.1. The varying geometry of stellar configurations as seen against the background of "immobile stars"

In sections 1 and 2 we tried to date the catalogue with rough methods based on various stellar configurations altering over the course of time due to the proper movements of individual stars that comprise them. We have considered each star in the configuration individually, comparing its calculated position to the one given in the Almagest. In order to compare all these positions we had to use the Newcomb theory that describes the movement of the ecliptic coordinate system used in the Almagest across the "sphere of immobile stars" over the course of time.

Let us see what results we can obtain from the method of dating the Almagest that will not use the Newcomb theory. The idea behind a method of this sort is simple. One doesn't compare the positions of individual stars on the "real" theoretically calculated star chart to their positions in the Almagest, but rather the geometry of stellar configurations (which change due to the proper movements of stars) to the configurations from the Almagest catalogue. The only thing required from us for such a comparison is the knowledge of velocity values of the individual stars' proper motion – not the Newcomb theory.

Although the errors resulting from the Newcomb theory are rather small (several orders smaller than the Almagest catalogue grade value), the study of configurations is a lot simpler this way from the calculus point of view.

Proper movements of stars are nowadays measured with great precision with the aid of telescopic observations ([1144] and [1197]). The values of proper star movements and the table that identifies the Almagest stars as their counterparts on the modern star charts comprise the only data that we are to use here. The identification table was borrowed from [1339]; we have omitted the ambiguous cases indicated therein.

3.2. The stars chosen for the experiment

We shall keep comparing the positions of all individual fast-moving stars on the real star chart with their positions as specified in the Almagest. However, now we shall be comparing the positions of the stars on the real chart and in the Almagest to a certain set of referential stars pointed out on the real star chart as well as the Almagest. For this set we have chosen either named stars (Aldebaran, Scheat etc), or those which definitely stand out in brightness amongst the stars that surround them. We excluded the stars whose coordinates might have been affected by refraction from the list of referential stars. 45 stars altogether were chosen, among them such visibly mobile ones as Arcturus, Sirius, Procyon, Capella, Aquila = Altair, Denebola, Caph and Regulus. Thus, the position of a mobile star on the real celestial sphere is determined in reference to a basis that is mobile as well. The resulting picture alters depending on the alleged dating and is compared to the respective picture as reflected in the Almagest.

Let us take the average configuration discrepancy of stellar arc distances as the deviation measure:

$$\overline{\Delta}_i(t) = \frac{1}{N}\sum_{j=1}^{N}\left|\rho_{real}(S_i, O_j, t) - \rho_{Alm}(S_i, O_j)\right|.$$

N stands for the quantity of referential stars, $\rho_{real}(S_i, O_j, t)$ is the arc distance between the star S_i and the referential star O_j on the real celestial sphere of epoch t. Furthermore, $\rho_{Alm}(S_i, O_j)$ is the arc distance between the star S_i and the Almagest star O_j. The time moment t_i when the value of $\overline{\Delta_i}(t)$ reaches its minimum shall be referred to as the individual dating by the star in question. If the individual dating values t_i for all the fast stars of the Almagest catalogue or at least their majority fall into a short enough time interval, said interval should either include the real date of Ptolemy's observations t_A or be located in its immediate vicinity. However, the real status quo appears to be altogether different.

3.3. The behaviour of the individual discrepancies and the average discrepancy

We have studied the behaviour of the $\overline{\Delta_i}(t)$ discrepancies for eight rather fast stars contained in the

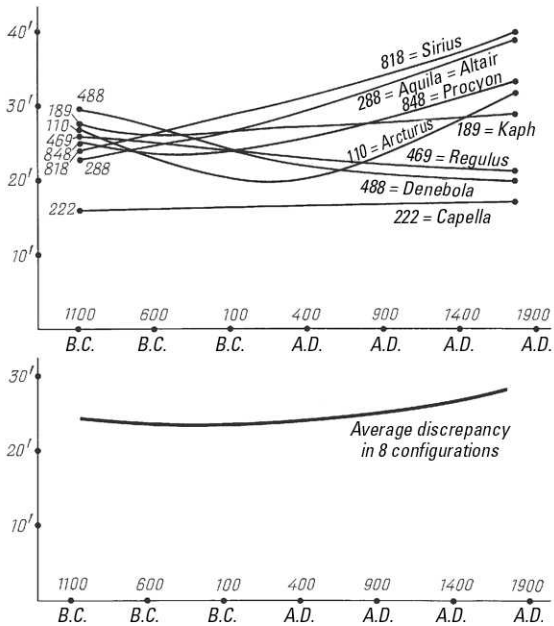


Fig. 3.13. Individual discrepancies for mobile stars and the average discrepancy in eight configurations. It is obvious that one can make no definite conclusions.

Almagest catalogue, namely, Capella (Bailey's number = 222), Arcturus (110), Aquila = Altair (288), Denebola (488), Regulus (469), Sirius (818), Procyon (848) and Caph (189).

We have deliberately chosen the most "famous" and the brightest of the Almagest's fast stars and omitted the dim ones. As we point out above, the coordinates of dimmer stars may be represented in the Almagest very imprecisely. Therefore, their inclusion into the sample can make the scatter range of individual datings a lot wider.

Fig. 3.13 demonstrates the graphs of individual discrepancies for the indicated fast stars $\overline{\Delta_i}(t)$ as t functions as well as the average graph for all these stars. Unfortunately, this graph turns out almost uniform over the entire time interval of 1100 B.C. – 1900 A.D. (see fig. 3.13).

3.4. Negative experiment result

Our refusal to use the Newcomb theory did not lead to the concentration of different datings by individual stars on the time axis. The implication is that the reasons for such a great scatter range of individual datings aren't related to the conversion method as applied to the coordinates of the celestial sphere, but rather relate to the low precision of coordinates offered by the dated catalogue, the possible heterogeneity of the catalogue etc. The latter might be caused by different positions of the instrumental ecliptic during measurements performed in different observatories, which produce different systematic errors for various groups of stars.

In section 5 of the present chapter we shall analyze the coordinates of the Almagest stars as well as the general structure of the Almagest catalogue in order to discover all the factors that might be causing this.

4. THE ANALYSIS OF SEVERAL ERRONEOUS WORKS ON THE SUBJECT OF DATING THE ALMAGEST BY PROPER STAR MOTIONS

4.1. A lot of the errors are not produced by astronomical phenomena and stem from the incorrect application of the methods offered by mathematical statistics

Let us analyze different authors' attempts to date the Almagest by proper star movements.

The articles of the astronomers Y. N. Yefremov and Y. D. Pavlovskaya ([273] and [274]) were published in reference to our publications; they represent an attempt to confirm the Scaligerian dating of the Almagest star catalogue by proper star motion. The corollary formulated in [273] is as follows. The Almagest catalogue can be dated to an early A.D. epoch by proper star motion with the precision threshold of ±100 years. The authors go as far as naming the date of 13 A.D. ±100 years.

In [274], which is a more in-depth publication, the authors formulate their corollary with more caution: "The Almagest star catalogue has thus already been observed in the antiquity; most probably, by Hipparchus. It is however possible that the brighter stars were observed by Ptolemy himself. Some sort of argumentation to support this can be found in the fact that the epochs that we got for Arcturus and Sirius, the two stars of the first magnitude present in our

sample, are 2-4 centuries more recent than those for the rest of the stars" ([274], pages 189-190).

However, the actual contents of [273] and [274] imply no such corollary. Let us briefly follow the reasoning patterns of Y. N. Yefremov and Y. D. Pavlovskaya using their more extensive publication ([274]), although everything we say shall also refer to their earlier work ([273]). Let us point out that Y. N. Yefremov hasn't made any scientific publications on this subject ever since the respective publications of said works ([273] and [274]) in 1987 and 1989. However, quite a few of his popular articles have appeared in newspapers and literary magazines. Still it has to be said that both his publications ([273] and [274]) contain errors which were pointed out to their author in our book [METH3]:2, pages 99-103. It would make sense for Mr. Yefremov to correct these errors prior to advertising the results of his research in popular press. Moreover, we are of the opinion that these errors cannot be corrected – in particular, due to the erroneous dating offered by Y. N. Yefremov, qv below.

The dating of star catalogues with the method described in [273] and [274] is based on the comparison of stellar configurations that alter over the course of time with the respective configurations as given in the Almagest. It turns out that the main part in the change of an individual configuration is played by a single star contained therein, the fastest one ("the group of Arcturus", "the group of τ Cet" etc). We shall be using the same terminology.

The dating of a catalogue by an individual configuration is supposed to be such a dating for which the set of pairwise distances between the stars of this changing configuration is the closest to the set of such distances as given in the Almagest. Proximity is defined in the square average sense.

What one gets as a result is naturally a certain approximation of the date when Ptolemy or some other observer who had compiled the Almagest catalogue were making observations – not the actual date. What are the possible discrepancy rates of such approximation, one wonders? There is no factual reply to this question given anywhere in [274].

The discussion of the issue of discrepancy rates for the resultant datings is left out in favour of a reference to the dependency graph of the square average discrepancy between the sets of pairwise distances in the Almagest as well as on the real celestial sphere and the alleged dating of the observations conducted by the author of the Almagest catalogue. We are told that "the epoch T_0 can be estimated with enough confidence, the minimum of the function $\overline{\Delta r^2}(t)$ being drastic and deep" ([274], page 183). However, the illustration that the authors of [274] are referring to (page 185, ill. 3) implies that the alteration of the alleged dating by 1000 years makes the value of the square average discrepancy $\sqrt{\overline{\Delta r^2}(t)}$ alter by a mere maximum of 13' for all configurations except for a single group, that of o^2 Eri. See more about this group below.

Let us see how significant the 13' deviation from the square average discrepancy really is for the situation regarded by Y. N. Yefremov and Y. D. Pavlovskaya. The Almagest scale grade value equals 10', whereas the real precision threshold of the stars in the Almagest estimated as the square average arc discrepancy equals roughly 30' (see [1339] and [614]). If we are to base our estimations on the proper movements of the stars under study, it will imply that the precision estimate according to the method offered in [274], which is based on the minimal square average configuration discrepancy, must allow for the value of this discrepancy to fluctuate within a much greater range than 13' – circa 20'-30'. This leads to the dating intervals of 2-3 millennia. In other words, the possible discrepancy rate for the dates cited in [274] equals 1000-1500 years. See more details concerning the precision of the method related in [273] and [274] below. However, dating the observations performed by the Almagest compiler with such low precision doesn't allow for making a distinction between Ptolemy's epoch and our age, let alone the Scaligerian datings of the respective lifetimes of Hipparchus (II century B.C.) and Ptolemy (II century A.D.). Such a result is of zero scientific value. It is obvious that the Almagest was created during the last two millennia at any rate.

Therefore, this error, as well as the ensuing mistakes made by the authors in question, is of a mathematical nature and not astronomical. The methods of mathematical statistics are either misused or altogether neglected. The claims made by Y. N. Yefremov in re the alleged "high precision" of his methods don't hold up to the simplest criticisms. It is most peculiar

that Y. N. Yefremov keeps insisting on the veracity of his erroneous results in the field of Almagest-dating publicly after all these years, the situation being as described above. This concerns his numerous public speeches and popular magazine and newspaper publications oriented at the general public.

4.2. The data in Y. N. Yefremov's works on the dating of the Almagest were tailored to fit the desired result

Y. N. Yefremov and Y. D. Pavlovskaya claim in [274] that the star catalogue dating method that they offer was tested on three veraciously dated catalogues – namely, the catalogues of Ulugbek, Tycho Brahe and Hevelius, and that the application of the method in question to all three catalogue gave an incredibly precise result. The dates when the catalogues of Tycho Brahe were compiled were "restored" with the precision threshold of 30-40 years, and Ulugbek's catalogue, the least precise of the three, was dated with the mind-boggling precision of ±3 years!

However, one cannot overlook the alarming circumstance that each of these datings was calculated by its own stellar configuration – namely, the datings for the catalogues of Tycho Brahe and Hevelius were obtained from the Arcturus groups, and the dating of Ulugbek's catalogue comes from the data obtained from the group of τ Cet. Other stellar configurations for each of the three catalogues in question aren't considered at all. Why would that be? We shall promptly answer this question.

Furthermore, the main result of Y. N. Yefremov and Y. D. Pavlovskaya concerning the dating of the Almagest is also de facto obtained from a single solitary configuration – group o^2 Eri, although they make formal references to having studied 13 configurations. The analysis of the datings that they came up with for all three catalogues demonstrates that in each case the choice of the actual stellar configuration used for the dating of the catalogue was conditioned by the Scaligerian dating of said catalogue's creation, whose veracity the authors of [273] and [274] were trying to prove. In other words, Y. N. Yefremov and Y. D. Pavlovskaya chose such stellar configurations for each catalogue in [274] that would concur best with the Scaligerian dating of the catalogue's compilation. A "method" such as this one is mere tailoring of research results in such a way that they would correspond to the desired values known a priori.

All of this makes the results claimed in [273] and [274] wholly insubstantial. These results are erroneous, and therefore cannot confirm the Scaligerian datings of the old star catalogues.

4.3. A vicious circle in the dating of the Almagest by the movement of the star o^2 Eri

Let us analyze the dating of the Almagest by the group of o^2 Eri as offered in the works of Y. N. Yefremov ([273] and [274]) in more detail, since it is this dating that Y. N. Yefremov bases his conclusions upon de facto.

We have already referred to the star o^2 Eri above, in section 1. Bear in mind that its identification as one of the Almagest stars is largely dependent on the alleged dating of the catalogue. In other words, the answer to the question of "who is who in the Almagest", or, in other words, whether the star o^2 from the constellation of Eridanus is represented in the Almagest at all, and if so, under which name, varies to a great extent as the a priori known dating of the catalogue changes.

Let us remind the reader that the star o^2 Eri moves fast enough, which changes its celestial position. In the course of its movement it becomes consecutively identified as different stars of the Almagest – namely, the three of them that one finds on the historical interval of the last 2,500 years. Bailey's numeration of these Almagest stars is as follows: 778, 779 and 780. The star #779 is traditionally identified as o^2 Eri (qv in [1339]) due to the mere fact that in the beginning of the new era the star o^2 Eri had occupied a position close to that of the star 779 on the Almagest star atlas.

However, what we face here is clearly an implication of the Almagest's being roughly dated to the beginning of the new era. If we are to make no presumptions in re the dating of the Almagest, we instantly find other candidates which we could identify as the moving star o^2 Eri. For instance, on the interval of 900-1900 A.D., the star which corresponds to the real position of o^2 Eri is #780. On the other hand, the star #779 from the Almagest does not remain

unidentified in this case either, since it can be successfully identified as the star 98 Heis (see [1339], page 117). Furthermore, this is the exact identification of this star which was made by the astronomer Pierce, qv in [1339].

We must emphasize that the star o^2 from the constellation of Eridanus is rather dim, likewise the ones that surround it. Their magnitudes range from 4.2 to 6.3. Therefore, the only way of identifying them as Almagest stars is coordinate comparison. The brightness of these stars is roughly the same, and Ptolemy's verbal descriptions of the stars in this part of Eridanus are laconic and extremely vague. Therefore, a reliable identification of these stars by any other properties but their coordinates is impossible. The "proof" of o^2 Eri being veraciously identified as a star from the Almagest catalogue as cited in [274] is based on late identifications of the Almagest stars, or, alternatively, upon dating the catalogue to II century A.D. in actuality. The use of such "proof" for independent dating obviously leads us to a vicious circle.

Therefore, what we see in the works of Y. N. Yefremov and his co-authors ([273] and [274]) is in fact the assumption that the Almagest was compiled in the early days of the new era used as the basis for the corollary that the Almagest dates to 13 A.D. ±100 years. This is the very vicious circle that we're talking about.

4.4. Y. N. Yefremov's errors in the precision estimation of dating the Almagest by Arcturus

Let us now turn to Arcturus – the second and last star discussed in the work of Y. N. Yefremov and Y. D. Pavlovskaya ([273]). The Almagest identification of the Arcturus is unambiguous. The first proper motion dating of the Almagest that we encounter in [273] is 250 A.D. Then the authors "adjust" this dating and end up with the dating of 310 A.D. ±360 years calculated by one of the configurations. We shall deal with this "adjustment" below.

The dubiety of the results published in [273] and [274] was also commented upon by other authors. M. Y. Shevchenko, for one, makes the justified remark in re [273] that "the catalogue dates to the I century B.C.; however, the precision and hence the veracity of this result leaves much to be desired so far" on page 184 of [968].

Simple considerations allow for an easy estimation of the real precision that the method's leading principle is based upon (as related in [273]). Indeed, the Almagest position of a given moving star is determined in relation to certain stars in its vicinity ([273]) – the "Arcturus group" in case of Arcturus. The Arcturus group contains 11 stars. The position of Arcturus in relation to this group is used for the estimation of its position on the star chart theoretically calculated backwards for the epoch *t*. These positions are then compared to each other.

All the stars of the Almagest are measured with errors of some sort. This definitely applies to the "group" stars – in particular, all the stars from the group of Arcturus. Let us however make the temporary presumption that the measurements of the stars in the vicinity of Arcturus were carried out with ideal precision. Even in this case the error rate in the Almagest location of Arcturus cannot be less than 10' by any coordinate, since this is the grade value of the Almagest star catalogue's coordinate scale. In reality, this rate has to be raised due to the imprecise coordinates of the stars in a given group.

This leads to the arc distance error of circa 14' for [273]. If the possible error rate for each of the coordinates equals 10', it shall equal 14' for the hypotenuse according to the Pythagorean theorem. Proper movement speed for Arcturus is roughly 2" per year. Therefore, Arcturus covers the distance of 14' in about 420 years. This is but a rough estimation of the "method's" precision.

In reality, the actual precision of the position of Arcturus in the Almagest may be given with an error rate that substantially exceeds 14', and the dim stars in its vicinity could be measured with even less precision. What we are referring to here is naturally the arc distance error. As we shall see below, the latitude of Arcturus was measured with sufficient precision in the Almagest – however, this does not apply to its longitude (see Robert Newton's research in [614], for instance). Moreover, one has no reasons to assume that Ptolemy measured any of the dim group stars precisely. Therefore, the real precision of the "method" related in [273] is a lot worse than 420 years. Therefore the interval of possible datings of the Almagest obtained with this method is a priori known to be greater than 200 B.C. – 700 A.D.

Let us now comment upon the random error modelling method as offered in [273] and [274] for the precision estimation of the resultant dating. For instance, this "method" brought Y. N. Yefremov to the conclusion that his dating of the Almagest to roughly 300 A.D. had the precision of ±300-400 years (see [273], page 311, and [274], page 181).

The method of minimal squares is used for the purposes of dating in [273] and [274]. The elementary calculations cited above demonstrate the precision of this method to be estimated in accordance to the individual error rate pertinent to the Almagest position of the star under study divided by the speed of its proper movement.

Y. N. Yefremov uses the method of random modulation of the Almagest errors in order to raise the precision of his method. The precision of the modelling method that he suggests (multiple perturbations of the Almagest star coordinates resulting from the application of some random value "comparable" to the catalogue precision) isn't estimated anywhere in his works. Nevertheless, this method will only work if the results of these random perturbations shall make the Almagest stellar coordinates approximate the real ones with "distinctive" probability. However, due to the effect of the individual error mentioned above, the probability of such coincidence with the area of real coordinates shall most probably be very low. At any rate, this probability has to be estimated; there isn't so much as a hint of such estimation anywhere in [274]. In general, the methods offered by the authors of [273] and [274] don't hold water from the point of view of mathematical statistics.

The "dating modelling method" as offered by Y. N. Yefremov can be formulated in the following manner. One is to consider a certain vicinity of a fast star – Arcturus, for instance. Then one is to use the method of minimal squares in order to determine the date which gives us a minimal square average discrepancy of the mutual distance set of the Almagest stars from the set of the same values in the real stellar configuration that alters over the course of time. This dating is used for the estimation of the real date when the catalogue was compiled, which is unknown. Y. N. Yefremov marks said dating as T_0.

Furthermore, the resultant minimum of square average discrepancy is for some reason declared to be the dispersion estimation of the local error in the Almagest catalogue. Y. N. Yefremov tells us rather plainly that "grouping the same *n* quantity of stars in different ways, we shall obtain a number of estimations $\varepsilon_{\lambda,\beta}$. They aren't independent; therefore, instead of averaging them we shall choose the maximal value which shall be considered the estimation of the local coordinate determination error in the Almagest catalogue" ([273], page 311). One wonders just why. Firstly, the local error of the Almagest has to be estimated separately, which is necessary for the understanding of just what minimal level variation we must allow for in order to reliably cover the real dating of the catalogue's compilation. When Y. N. Yefremov takes the actual minimal value for dispersion estimation, he basically fails to allow for the variation of this minimum altogether.

Secondly, the sample volume used for the averaging of the value in question is too small (circa 5-6 independent observations) and doesn't permit to consider Y. N. Yefremov's estimation precise enough. Local error needs to be estimated from a much greater quantity of stars.

Furthermore, Y. N. Yefremov models random perturbations of Ptolemy's coordinates using his "estimated" local error rate as basis. He writes that "the knowledge of the error rate $\varepsilon_{\lambda,\beta}$ for each group makes it feasible to conduct a numerical experiment in order to study how the estimation of T_0 is affected by random coordinate errors. Let us model the corrections of stellar coordinates from the Almagest catalogue, considering these corrections to be distributed normally with the average of zero and the square average error $\varepsilon_{\lambda,\beta}$ for each group and calculate the respective value of T_0. Having repeated the procedure 100 times, we can build a distribution graph for the resultant estimations of T_0" ([273], page 312). Y. N. Yefremov proceeds to tell us that "the common interval for all the groups with the square average errors for the epochs of $\overline{T_0}$ taken into account is the I century B.C." ([273], page 313). Y. N. Yefremov also makes the following flabbergasting statement: "the probability rate of T_0's random value exceeds 900 equals 0.2, and that for a group with maximal dispersion. Therefore, the Almagest catalogue is most unlikely to be a mediaeval forgery" ([274], pages 188-189). Thus, Y. N. Yefremov apparently assumes that the average date must be

close enough to his "randomly modelled date" $\overline{T_0}$, estimating this proximity whilst "taking the square average errors as calculated above into account" ([273], page 313).

This approach is utterly delusional. It is obvious that what Y. N. Yefremov determines to be the average modelled date $\overline{T_0}$ is merely his initial estimation of T_0 with some random perturbation added thereto by the author himself. As for the distribution of modelled dates, what he comes up with is a random dispersion with the centre equalling T_0 for a given group. Y. N. Yefremov is of the opinion that the real date must be close to the centre of this dispersion, or, in other words, that the random perturbations that he introduced have a certain real probability of covering the real positions of Ptolemy's stars. In other words, he hopes that his modelling will randomly cancel out Ptolemy's errors, estimating their probability to be real. This is the exact meaning of the passage quoted above where Y. N. Yefremov tells us that a post-900 A.D. dating can only be achieved in the course of this modelling with "the minute probability rate of 0.2". He is of the opinion that this makes a mediaeval dating of the Almagest highly improbable.

However, one has to bear in mind that his initial dating T_0, which the modelled datings are grouped around differs from the real date by a certain value. The value of this shift, as we have demonstrated above by simple calculations, can be great enough. In case of Arcturus its lowest possible value is 420 years, qv above. Said shift is defined by Ptolemy's individual error in the estimation of a given star's coordinates, as well as individual errors for the stars of the chosen group. Also, our calculations demonstrate that the value in question is largely dependent on the group choice. Therefore, some individual error is already inherent in the value T_0, possibly a serious one. When Y. N. Yefremov "models" his additional errors for group stars, he already distributes them around a certain dating which might be shifted sideways to a substantial degree. However, in his reference to the graphs of modelled distributions, Y. N. Yefremov appears to assume that the real dating must be located near the centre of these distributions in every case – at least, within a certain confidence interval with the probability ratio of 0.8, since he considers the probability of 0.2 to be too low.

This is untrue. The abovementioned simple estimation demonstrates the real date to be far enough from the centre of such modelled distribution (for instance, this range exceeds 420 years for Arcturus, qv above). At the same time, the scatter range of modelled dates around a shifted date might not be all that great. The matter is that Y. N. Yefremov takes an unreasonably low value of the square average error obtained from parabolic minimum for this modelling, making no specific estimations of this error for some reason.

Apart from that, it is easy enough to estimate that even if one is to model the correction for the coordinates of a single star, the probability of returning to its true position is very small in general. This is confirmed by the following simple calculation. Let us assume that Ptolemy's individual error for a given star equals 45 arc minutes. Such errors are typical for the Almagest – a great number of stars it contains were measured a lot worse ([1339]). Let us re-emphasize that we are referring to the arc error. Latitudinal errors are a lot smaller, as we shall demonstrate below.

If we apply the above calculations to Arcturus, for instance, the implication is that in order to model an actual dating that would differ from the original by 400 years maximum, one has to "hit" the 14-minute range around the star's real location (provided that the group stars have already fallen into necessary positions and do not affect the dating too greatly). The maximum probability of the value falling into this 14-minute range from a position shifted by 45' can be estimated as the probability of its falling into the shaded sector on fig. 3.13a.

If we are to consider the probability of a perturbed point being located in the 60' radius of point A to equal 1, we end up with the probability of 0.1 for its location in the shaded sector. Thus, even in this ideal case the probability rate of obtaining the necessary dating randomly – not even the correct dating, but rather one that won't differ from it by more than 400 years, equals 0.1. Still, Y. N. Yefremov is of the opinion that the probability threshold of 0.2 already suffices for rejecting the post-900 A.D. datings as improbable.

The authors of [274] claim that the results of calculations performed by other fast stars (which aren't cited in their work for some reason) confirm the con-

clusions made in the research of Arcturus and o^2 Eridani. However, this statement does not correspond to reality.

Let us provide a single vivid example. Among the fast stars which were processed by the authors of [273] and [274] we find Procyon, a star which was famous in mediaeval astronomy. Our research (qv in section 1, for instance) demonstrates that Y. N. Yefremov's method must have led to the dating of roughly the X century A.D. by Procyon, which would blatantly contradict his conclusions. For a mysterious reason, [273] tells us absolutely nothing about the results for Procyon.

Finally, the "method" related in [273] and [274] is largely dependent on the group contingent choice for the fast star under study. We have checked how the result of the dating by the Arcturus group changes depending on the choice of various stars for this group. It turns out that when we change the contingent of the group, the Arcturus dating may vary from 0 A.D. to 1000 A.D. – that is, the results can fluctuate with the amplitude of up to a thousand years. This very circumstance completely invalidates the method offered by Y. N. Yefremov.

Corrolaries:

1. The result of dating the Almagest by proper star motions as claimed by Y. N. Yefremov and Y. D. Pavlovskaya in [273] and [274] is based on thin air. Furthermore, some of the considerations one encounters in said works contain a "vicious circle".

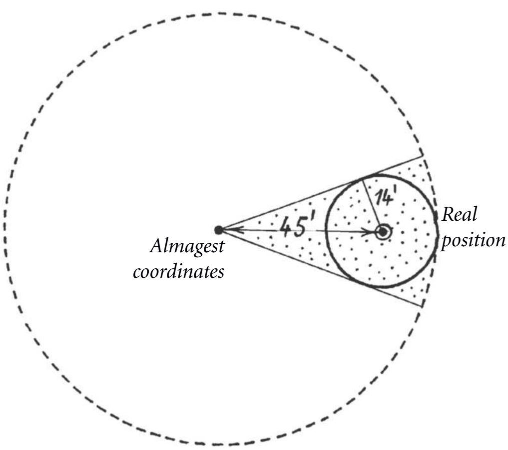


Fig. 3.13a.

2. If we are to strip the works in question ([273] and [274]) from all such "circular" considerations, the "discrepancy" we end up with does not contradict our dating, qv below.

3. The positions of Y. N. Yefremov and Y. D. Pavlovskaya that concern the precision estimates of their method (and the correction modelling of the Almagest) as seen in [273] and [274] are mathematically illiterate and void of meaning in our opinion.

4. The authors of [273] and [274] failed to consider Procyon, which gives a blatantly non-Scaligerian dating, for some "unknown reason".

The work of Y. N. Yefremov and Y. D. Pavlovskaya ([273]) was published in the "Doklady Akademii Nauk SSSR" in 1987. We pointed out the errors contained in [273] and [274] in our articles [350] and [355], which were published in the "Doklady Akademii Nauk SSSR" in 1989 and 1990, respectively. Apart from that, we have personally addressed Y. N. Yefremov with a criticism of his errors at the seminar hosted by the Institute of Natural Scientific and Technical History in 1989. Y. N. Yefremov did nothing to rectify the errors in question – moreover, he evades all attempts of their discussion.

4.5. Erroneous precision estimation of astronomical calculations: another example

Let us consider another publication that deals with the issue of Almagest dating ([179]). Its authors, Y. S. Goloubtsova and Y. A. Zavenyagin, refer to Galley reporting that over the time that passed between Ptolemy and Galley (up to 1690, which is when Flamsteed's star catalogue was created), Arcturus shifted in the Virgo direction by 1.1 degrees. Having compared this to the annual shift value for Arcturus (2.285"), Goloubtsova and Zavenyagin perform the following simple calculation, writing that "if we are to divide 1.1 degrees by 2.285 angular seconds per year, we end up with 1733 years. Finally, once we subtract 1733 from 1690 (or the year when Flamsteed's catalogue was compiled), we shall come to the conclusion that the Almagest catalogue was compiled in 43 B.C. The discrepancy error rate for the coordinates of neighbouring stars is a lot smaller than the error of the actual coordinate, since the subtraction removes the systematic error. Therefore, the average

error rate in the positions of bright stars in relation to their neighbours in the Almagest does not exceed 0.1 degrees [? – Auth.]. The implication is that the possible dating error rate does not exceed 150 years" ([179], page 75).

Thus, if the authors of [273] date the catalogue to 250 A.D. by Arcturus (and even to 310 A.D. after making their "adjustment", estimate precision equalling ±360 years in this case), the authors of [179] perform a single solitary arithmetical calculation and date the Almagest to 43 A.D., also by Arcturus, with the much greater precision rate of ±150 years.

However, the text from [179] as quoted above is oriented at the reader who will not bother checking the real stellar configuration on the celestial sphere. The calculations of the authors of [179] are based on the taciturn implication that the own movement vector of the modern Arcturus is directed exactly at its Almagest location. Had this indeed been the case, their calculations would have some sort of reasoning to back them up. However, this doesn't appear to be the case. In fig. 3.1 one sees the real movement direction of Arcturus in relation to its position as specified in the Almagest. One can plainly see that Arcturus moves visibly "sideways" from its Almagest position. Therefore, it isn't the value of 1.1 degrees that has to be divided by 2", the way it is done by the authors of [179] for some reason, but one that is a great deal smaller, and shall yield the dating of approximately 900 A.D., albeit with a significant possible error rate due to the rough nature of the method itself. See our considerations in re the precision of this method above.

Thus, dating the Almagest to 43 A.D. with the possible discrepancy rate of ±150 years, as Y. S. Goloubtsova and Y. A. Zavenyagin claim to have done, is completely out of the question.

Let us also point out that the very "concept" behind [179], which implies the random errors in the Almagest to be a result of proper star movement, is perfectly erroneous. Its absurdity is all the more obvious if we are to consider the examples of slowly moving stars which are almost immobile. The division of a non-zero error of the Almagest in the position of a star might yield any "infinitely ancient" observation dating.

The claim made by the authors of [179] in re the error in the bright stars' positions in the Almagest not exceeding 0.1 degrees, or 6', isn't based on anything whatsoever. Why 6' and not 2' or 15'? Having said everything about the precision estimation problem of the Almagest stellar coordinates, we deem a deeper study of this issue superfluous.

The authors of [179] did not limit their research to the study of Arcturus and its behaviour. They also attempted to date the catalogue by another "fast" and well-known star – Procyon. Let us quote: "We get a similar result once we date the Almagest by the proper movement of Procyon, namely, that the Almagest catalogue was compiled in 330 B.C., with the possible error rate of ±300 years… The Procyon dating serves as a perfectly independent corroboration of the Arcturus dating, both of which take us to the last centuries before the new era" ([179], pages 75-76).

However, just as they had done in case of Arcturus, the authors did not take the direction of Procyon's movement into account for some reason. Let us see what "dating" we shall get if we are to use their "method" for our own accurate calculations which take real stellar positions into account. It turns out that the real trajectory of Procyon's movement is such that a rough Procyon dating is the X century A.D., no less (see section 1). It goes without saying that the issue of this dating's precision remains standing.

4.6. The "secondary analysis" of the Almagest dating in the "Samoobrazovaniye" ("Autodidactics") magazine

In the first 1999 issue of the Muscovite magazine "Samoobrazovaniye" ([263]) we find a publication by A. S. Doubrovskiy, N. N. Nepeyvoda and Y. A. Chikanov entitled "On the Chronology of Ptolemy's 'Almagest'. A secondary mathematical and methodological analysis" which deals with our dating of the Almagest by proper star movements in particular.

Unfortunately, the authors of [263] failed to familiarize themselves with the necessary astronomical issues and thus made the false conclusion that the dating of the Almagest by proper star movements is unreliable in general, as the speeds of proper star movements are known rather badly, which is presumably reflected in great controversy one finds in astronomical literature.

Further in [263] we encounter a comparative table of proper movements as taken from the "Astronomicheskiy Yezhegodnik" ("The Astronomical Yearly") and the catalogue [1197]. For instance, the reader is invited to compare the values contained in both catalogues (-0.1098; -0.2001) and (-1.155; -1.998) respectively. These are the proper movement speeds of Arcturus.

The authors of [263] tell us exactly the following in this respect: "As for the analysis of the "fast" star motion, we must point out that the data concerning the stellar speed taken by Fomenko's group from the catalogue… [followed by a reference to the bright star catalogue ([1197]) – Auth.] differ considerably from those contained in the "Astronomicheskiy Yezhegodnik" ([263], page 23).

Having cited this remarkable table on page 24 of [263], its authors come to the following conclusion: "As one sees from the table, estimating the age of the catalogue by proper star movements is a more than dubious activity which doesn't stand up to criticism". However, the speed vector compounds which are compared in this table weren't just given in different coordinate systems, but also in different measurement units! This is easy to observe from the above example – we're dealing with the equatorial coordinate system for the epoch of 2000 A.D. in one case and the equatorial coordinate system for the epoch of 1900 A.D. in the other. These coordinate systems differ from each other. The above example demonstrates the scale discrepancy. According to the Pythagorean theorem, the given vector speed components of Arcturus suffice for the calculation of said vector's length which shall already be independent from the coordinate system. However, in the first case it is ten times smaller than in the second, which stems from the fact that different catalogues use different proper movement scales. In one case the measurement unit used equals 1/1000th of a second per year, and in the other it is 1 second per century. The units differ by a factor of ten.

One needs no commentary here. It is obvious that before suggesting that the reader should compare any values of any kind, said values need to be given in the same scale.

We shall refrain from discussing the authors' own attempts of dating the Almagest ([263]), merely stating that we are of the opinion that the dating of the Almagest has to be preceded by an in-depth study of certain rather complex issues from the part of the researcher. It actually requires a great deal of time and effort, even from a specialist.

5. CONCLUSIONS AND DIRECTIONS FOR FURTHER RESEARCH. OUR APPROACH AND A BRIEF SYNOPSIS OF OUR MAIN RESULTS

5.1. The three problems one is confronted with: identifying the Almagest stars, defining the nature of possible errors, and analysing the precision of the catalogue

Sections 1-3 contain accounts of several attempts to date the Almagest on the basis of the numerical material contained in Ptolemy's star catalogue. All of these attempts has proven futile. We have discussed them in such great detail for two reasons – firstly, the reader can get a better idea of what the complexities of the "self-sufficient" dating of the star catalogue really are – the dating that would be based on nothing but the catalogue's numerical material, that is. Secondly, we wanted to provide some basis for raising the issues that we shall relate in more detail further on.

The main corollary that we come to at the present stage is as follows. The dating of the Almagest requires a meticulous preliminary analysis of the catalogue. This analysis must relate to the following issues.

1. Identifying the Almagest stars as the ones observed on the contemporary celestial sphere. In section 1 we demonstrate that this problem doesn't always have an unambiguous solution; furthermore, the solution in question might depend on the alleged dating of the catalogue. Therefore, before we can proceed with dating, we have to find and reject all cases of dubious identification of the Almagest stars as their modern counterparts.

2. The nature of possible errors contained in the Almagest catalogue. The error rates in stellar coordinates characteristic for the Almagest lead one to the conclusion that the dating of the catalogue cannot be estimated with more precision on the historical interval as based on proper star movements. However, this statement becomes generally false if we manage to discover the systematic compound in the errors of

the Almagest star positions. In this case we may get an opportunity to compensate it, thus raising the precision of the catalogue, which, in turn, may allow us to date the latter regardless of the error in question.

3. The precision of the Almagest catalogue attained with different stellar subsets. The goal of this analysis is the choice of the star group from the Almagest whose coordinates must have been measured by Ptolemy with some guaranteed precision level δ. Once we manage to locate such a group, it shall define the set of possible Almagest datings, namely, making feasible the datings that will allow the guaranteed precision level δ to be attained for the stars of this group. If the resultant dating interval proves to be a great deal shorter than the a priori known historical interval, we shall obtain purposeful information about the date when the Almagest star catalogue was compiled. This concept shall be used below (see Chapters 5-7).

Let us briefly discuss each of the three issues as listed above. Their more detailed rendition can be found in the chapters to follow.

5.2. The identification of the Almagest stars

There is a rather large amount of handwritten copies as well as several mediaeval printed versions of the Almagest where the ecliptic coordinates of individual stars differ from one another. Most of these copies and editions (although not all) were brought to roughly 60 A.D. by precession. The implication is that if one were to compare the stellar longitudes from a given copy of the Almagest with the precisely calculated stellar longitudes for 60 A.D., the average discrepancy rate shall equal zero. Such a comparison is only possible due to the fact that identifying most of the Almagest stars with those on the modern celestial sphere leaves no room for doubt.

The source text that we used was the Almagest catalogue containing over a thousand stars in the exact same form as it is given in the fundamental work of K. Peters and E. Knobel ([1339]). Several coordinate variants from [1339] were also included in the list of stars under analysis. In the preliminary stage we neither doubted the veracity of stellar coordinates from the Almagest, nor the fact that they were given in ecliptic coordinates rendered to 60 A.D. due to precession.

As it has already been mentioned, [1339] contains the identifications of the Almagest stars as their modern counterparts. Nevertheless, we have conducted the identification process from scratch in order to select the stars to be analyzed, see Chapter 4. The identifications contained in [1339] were thus confirmed for the most part.

However, we have discovered several modern stars that can be identified as different Almagest stars for different epochs *t*. Such are o^2 Eri and μ Cas, for instance. These stars were identified in [1339] under the assumption that Ptolemy's observations were conducted around the beginning of the new era. Basing the dating of the Almagest catalogue on the analysis of such stars makes no sense, for we shall simply end up with a vicious circle. All such stars were excluded from further consideration.

Let us also point out that the identifications and coordinates of the stars o^2 Eri and μ Cas are considered doubtful.

5.3. Various types of errors in the catalogue

We have demonstrated above that a simple comparison of the calculated stellar coordinates to those contained in the Almagest catalogue doesn't permit to estimate the dating of the latter. This is explained by the huge discrepancy rates inherent in the Almagest catalogue for the most part. Therefore, we can only succeed if we analyze the Almagest errors of different nature meticulously.

We shall divide the errors into three types: group errors, random errors and "rejects".

Under group errors we shall understand various data distortions resulting from observations or recalculations and leading to the shift of a star group on the celestial group as a whole.

Random errors are of an individual character and owe their existence to imprecise observations ranging within the grade value of the measurement instrument for the most part. A distinctive trait of such errors is that they shift each star on the celestial sphere by a random value which has a zero average.

Rejects are a product of circumstances which were either unforeseen by the compiler or unknown to him: copy errors, refraction etc. They also affect the coordinates of individual stars, and their values are

usually much greater than the measurement instrument scale precision. Rejects are a rather scarce type of error.

The most important task is to define and compensate the group errors. Suitable methods are discussed in Chapter 5 where, apart from providing the formulae necessary for their calculation, we also demonstrate how to determine the precision of the resulting values.

The estimation of different types of errors in the Almagest stellar coordinates is dealt with in Chapter 6. We find out that the coordinates of stars as given in the Almagest do indeed contain significant group errors manifest as the shifts of the respective stellar configurations on the celestial sphere as a whole.

The values of group errors may in fact differ for various stellar groups – constellations, for instance, hence their name. However, we shall witness that insofar as large enough celestial areas are concerned, group errors of the Almagest and other old star catalogues coincide for various constellations and equal the single error for the entire area. We shall refer to such an error as the systematic error of a given catalogue for a given celestial area.

Each of the shifts defining a group error can be described by three parameters. We shall choose the following base errors as such, qv in fig. 1.1, Chapter 1.

Error τ in the location of the vernal equinox point $Q(t_A)$ made by the observer in the observation year t_A in the ecliptic direction. In other words, τ is the projection of the Almagest catalogue vernal equinox point shift sideways from its real position over the ecliptic.

Error β in the location of point $Q(t_A)$ in the direction of the meridian, or the projection of the error vector over the ecliptic meridian.

Error γ in the angle ε between the ecliptic and the equator. The change of a star's ecliptic coordinates by the ground observer needs to be preceded by the estimation of the angle ε between the ecliptic and the equator, regardless of the measurement method. If the observer made the error γ in the estimation of said angle, the ecliptic of the catalogue shall be shifted in relation to the position of the real ecliptic in the observation year by the value of γ.

The possibility that group errors may be inherent in the Almagest has been discussed by many researchers – see [1339], [614] and [544], for instance. We shall merely mention possible reasons for the existence of such errors here.

Error τ might result from the fact that the observer or a later compiler of the catalogue had for some reason "adjusted" the catalogue to make it fit a dating that would differ from that of the real observation. It is possible that this operation used to serve some methodological end – for instance, making the catalogue conform to some round or important date. It could also have been used for a deliberate distortion of the real observation date ([614]), or, alternatively, it may result from changes in the initial longitudinal reference point. We have already demonstrated that ancient astronomers could count longitude from various points on the ecliptic. A change of the initial reference point would naturally lead to some constant being added to all ecliptic longitudes and hence the alteration of the catalogue's "dating", if it were to be dated by longitudinal precession.

It is understandable that the latitude of a star is independent from error τ. This makes latitudinal coordinates more reliable, which is the very reason why we shall be considering longitudes and latitudes separately. The consideration of latitudinal discrepancies requires just two parameters to define a group error – β and γ, for instance.

What is there to say about the values of β and γ? Equatorial latitudes of stars are easy enough to determine from actual observation with enough simplicity and precision ([75]). Therefore, one should expect error β to be small enough for the moment of observation, provided the observer was accurate enough. Error γ is of a principally different character. The determination of the ecliptic position is achieved as a result of rather complex observations and calculations, qv in Chapter 1. Therefore, the value of error γ might be significantly greater than that of error β.

The works [544] and [1339] contain indications at the fact that the systematic error γ is indeed inherent in the Almagest. Moreover, some of the Almagest's researchers estimated the value of this error as roughly 20'. Our calculations confirm this, qv in Chapter 6.

We shall occasionally use parameters φ and γ instead of β and γ since they are more convenient from

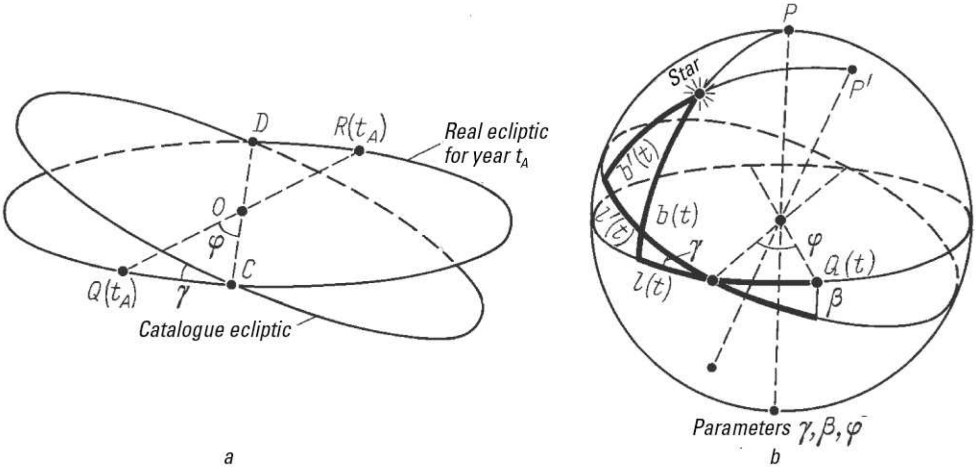


Fig. 3.14. Specifying the parameters of the systematic error in the ecliptic coordinates of the stars with the aid of the parameters γ and φ or γ and β. In the present example τ = 0.

the point of view of calculation. Their meaning is clarified in fig. 3.14. Inasmuch as the latitudinal discrepancies are concerned, the group error is rendered to a mere misplacement of the ecliptic plane, which we shall be referring to as the "catalogue ecliptic". One can define the mutual disposition of the catalogue ecliptic and real ecliptic plane for catalogue compilation epoch t_A if one is to fix angle φ between the equinox axis *QR* for epoch t_A and the plane rotation axis *CD*, as well as fixing the plane angle γ between the two ecliptic planes – the true and the false. We shall hereinafter define the parameters of group errors with the values of φ and γ for the most part.

Generally speaking, the compiler of the catalogue may have made different group errors in his study of different celestial areas. Possible reasons include instrument readjustment, the choice of a different observation point etc.

In Chapter 2 we discover seven parts of the Almagest star catalogues which are naturally distinctive as seen on the celestial sphere, and differ by their reliability characteristics in the Almagest, see fig. 2.14. In Chapter 6 we shall see that the same celestial areas in the Almagest also differ in group error values and precision characteristics.

To sum up, one can say that the reasons for the existence of group errors and other discrepancies as listed above only serve to explain the possible mechanisms of error genesis. Calculations allow the discovery of errors themselves but tell us nothing of how and why they were made – possible reasons may differ from the abovementioned.

5.4. The discovery of the systematic error in the Almagest catalogue. Its compensation confirms the correctness of the declared catalogue precision

The real moment t_A of the catalogue's compilation remains unknown to us. Therefore we should calculate the values of parameters $\gamma(t)$ and $\varphi(t)$. The calculation method is a combination of the minimal square method and the spherical regression problem. Its precision properties are discussed in Chapter 5.

The results of our calculations can be represented as graphs $\gamma_{stat}(t)$ and $\varphi_{stat}(t)$, qv in fig. 3.15. These graphs were built after the processing of the Almagest stellar coordinates for large celestial areas. The "stat" index indicates that the corresponding values were educed by methods of statistics. They are actually estimates of discrepancy parameters inherent in the positions of the Almagest stars, and demonstrate said discrepancy to be uniform for several large areas of the celestial sphere. The estimations were made under the assumption that the catalogue was compiled in epoch t, and are thus t functions. We shall be using

the term "systematic errors" for the error in question as well as its compounds, parameters $\gamma(t)$ and $\varphi(t)$.

What is the relation between these errors and group errors? If the large celestial area under study consists of several constellations, systematic errors discovered with the aid of statistical methods shall represent averaged group error values for different constellations. It is only in case when all group errors equal each other that they coincide with the respective systematic error.

This is the only case where we shall not differentiate between the definitions of "group error" and "systematic error".

We have built confidence intervals I_γ and I_φ of acceptable γ and φ values around each value of $\gamma_{stat}(t)$ and $\varphi_{stat}(t)$. Let us clarify that γ_{stat} and φ_{stat} are but punctual statistical estimations of unknown parameters; the latter define the systematic error made by the compiler of the catalogue, and the values of such estimations are by no means equal to the values of actual unknown parameters. Once we build the confidence intervals around the calculated punctual estimates γ_{stat} and φ_{stat}, we can claim the true parameter values to fall into these intervals with a given degree of certainty.

The method of building confidence intervals, which is widely used in statistical problems, is related in Chapter 5. Actual results pertaining to the Almagest are cited in Chapter 6.

We have conducted an analysis of errors for all seven celestial areas of the Almagest as discovered above, having determined their respective systematic error values as well as the values of the "remaining" square average latitudinal discrepancies resulting from the compensation of the discovered conditional systematic errors. What we discovered as a result was that areas *A* and *Zod A* are the most precisely-measured of all, qv in Chapter 6 and table 2.3. A propos, these are the areas where most of the named Almagest stars are located. Another discovery was that after the compensation of systematic error, more than half the stars from area *A* ended up with the latitudinal discrepancy of 10' maximum (see Chapter 6). The percentage of such "well-measured" stars is even greater for area *Zod A* – 63.7%. Thus, the declared 10' precision rate of the catalogue was confirmed for the latitudes of the majority of stars from a rather large celestial area.

The next issue that we are confronted with is the nature of the discovered parameters γ_{stat} and φ_{stat}. Is it true that the calculated values of γ_{stat} and φ_{stat} are close enough to real group errors for the entire catalogue, or at least the stars from area *A*?

It is quite possible that the compiler of the catalogue made individual group errors for each constellation; in this case, the values that we have calculated shall de facto represent a sum of various averaged group errors, the result of such averaging being nonzero due to the relatively small number of constellations in general.

In order to answer this question, we have considered all the Zodiacal constellations and the "neighbourhoods" of most named stars. Calculations have shown that the value of $\gamma_{stat}^{Zod\ A}$ as calculated for area

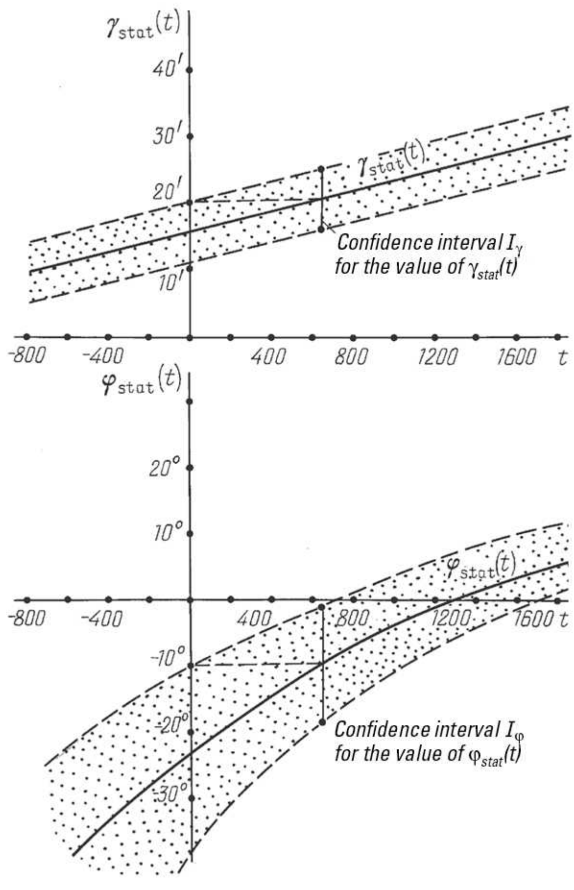


Fig. 3.15. The behaviour of parameters $\gamma_{stat}(t)$ and $\varphi_{stat}(t)$ in time.

Zod A applies to all the constellations from area *A* at least. In other terms, $\gamma_{stat}^{Zod\,A}$ should be regarded as the systematic compound that affects all the stars from the well-measured celestial area *A* which also contains most of the named stars. However, we can make no such claim for the value of $\varphi_{stat}^{Zod\,A}$. It is curious that this conclusion about the nature of compounds γ_{stat} and φ_{stat} can serve as argumentation in favour of the theory that the coordinate measurements for the Almagest catalogue were conducted with the use of the armillary sphere. See Chapter 6 for more details.

5.5. The compensation of the systematic error discovered in the catalogue gives us an opportunity of dating the latter

The compensation of the discovered systematic error allowed us to reduce the latitudinal discrepancy for area *Zod A* of the Almagest from 17.7' to 12.8'. This resulted in the possibility of dating the catalogue.

We have already pointed out that the declared 10-minute precision rate of the Almagest is indeed attained for most of the stars in the catalogue. The question that one comes up with here is whether there are any stars at all for which the declared Almagest precision rate will be guaranteed?

It is known that the observer always uses the system of referential points, or stars, on the celestial sphere in stellar coordinate measurements, qv in [968], for instance. This measurement method is natural and has been used by all mediaeval astronomers. Tycho Brahe, for one, used 21 referential stars for his measurements ([1049]). The modern system of referential points consists of several thousand stars which are collected in the so-called fundamental catalogues (see catalogue FK4, for instance – [1144]). The Almagest contains indications that Regulus and Spica must be among these referential stars. Special sections of the Almagest are dedicated to the measurement of their coordinates.

Let us formulate the following axiom. If the declared precision of the catalogue is confirmed, it should be guaranteed for the majority of the referential stars from the catalogue in question.

What are the stars that should have necessarily been included in the number of the Almagest's referential stars? First and foremost, Ptolemy must have used those of the stars which have names of their own in his catalogue. There aren't too many such stars – only twelve. They really comprise a very convenient basis in the visible part of the sky. Their complete list is as follows: Arcturus, Regulus, Spica, Previndemiatrix, Capella, Lyra = Vega, Procyon, Sirius, Antares, Aquila = Altair, Aselli and Canopus; twelve stars altogether.

All of these stars are bright and clearly visible against their background. What is especially important for the purposes of dating, some of them have a rather high proper movement speed – for instance, Arcturus, Procyon and Sirius. Some of the others also shift across the celestial sphere rather visibly, namely, Regulus, Capella, Antares and Aquila = Altair.

However, we had to exclude two of the twelve stars from consideration instantly – namely, Canopus and Previndemiatrix, the reason being that Ptolemy's coordinates of Canopus were greatly affected by refraction, and they can be regarded as a "reject" from the statistical point of view; as for Previndemiatrix, Ptolemy's initial coordinates of this star were lost, and simply remain unknown to us today, qv in Chapter 2.

Two more stars (Sirius and Aquila, or Altair) were rejected due to the fact that the systematic error is different in their case, as our analysis shows, and the value of said error cannot be determined for these two stars. Therefore, the dating of the Almagest catalogue was made on the basis of the remaining 8 named stars. Their list is as follows:

Arcturus, 16, α Boo, Bailey's Almagest number 110;
Regulus, 32, α Leo, number 469;
Spica, 67, α Vir, number 510;
Capella, 13, α Aur, number 222;
Lyra = Vega, 3, α Lyr, number 149;
Procyon, 10, α CMi, number 848;
Antares, 21, α Sco, number 553;
Aselli, 43, γ Cnc, number 452.

5.6. The dating of the Almagest catalogue by the motion of its eight primary basis stars after the rectification of the statistically discovered catalogue error

The proposed hypothesis leads us to the implication that for the desired catalogue compilation epoch t_A, all of the eight named basis stars of the Almagest must have a maximal latitudinal discrepancy of 10'.

On the other hand, we know that the catalogue's systematic discrepancy compound γ must fall into the confidence interval I_γ built around the statistical estimation $\gamma_{stat}(t_A)$ for epoch t_A. We thus come to a natural dating method.

Let us consider the confidence interval I_γ around $\gamma_{stat}(t)$ with the value of t and the level of confidence being fixed and select a certain subset S_t from values that fall into it, which will compensate the given systematic error compound γ and make the latitudinal discrepancies for all of the eight named basis stars less than 10', or the grade value of the Almagest catalogue coordinate scale, with γ in S_t, qv in fig. 3.16.

In general, set S_t can be empty. Let us find all the values of the presumed datings t for which the sets S_t are not empty. These very values shall comprise the possible dating interval, since for all of the presumed datings t from this interval the latitudes of all eight named stars are measured with the precision rate of 10'.

We shall refer to the described dating procedure as "statistical", since it is based on the values of $\gamma_{stat}(t)$ discovered with statistical methods. A more explicit description of this procedure can be found below, in Chapter 7, alongside a detailed discussion of the achieved dating results.

It turns out that the dating interval begins in 600 A.D. and ends in 1300 B.C. Although its length equals 700 years due to the low precision of the Almagest, this interval is located at a considerable distance from the Scaligerian dating of the Almagest's creation.

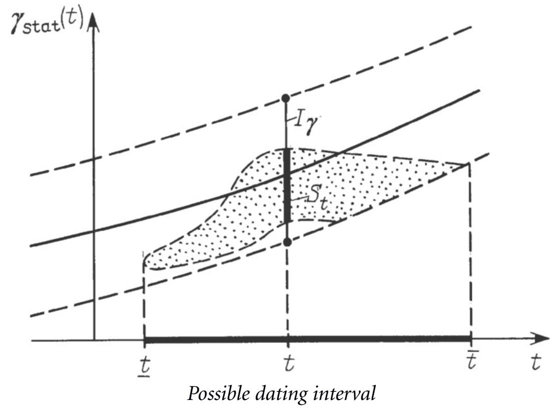


Fig. 3.16. Dating the Almagest catalogue with the statistical method.

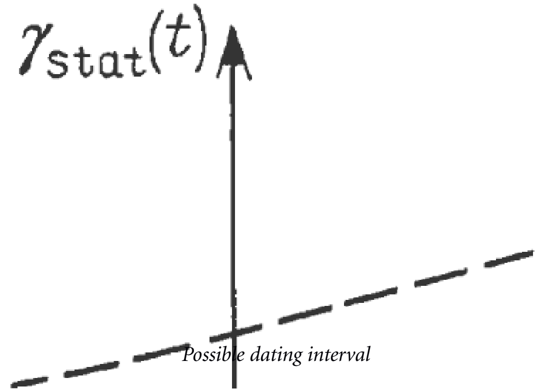
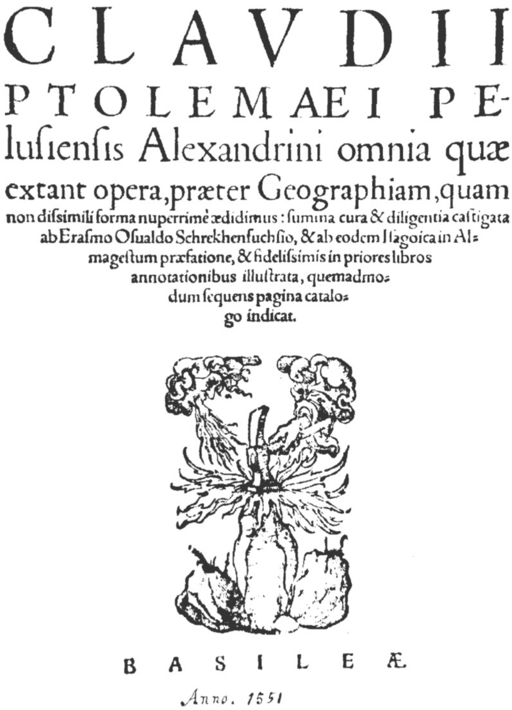


Fig. 3.17. Dating the Almagest catalogue with the geometrical method.

5.7. The dating of the Almagest catalogue by the motions of its eight named basis stars by an independent geometrical method

The confidence intervals used for the statistical procedure contained a certain subjectively chosen parameter, namely, the level of confidence, which represents the minute probability which we can disregard in statistical corollaries. Therefore one can actually discuss the issue of the dating interval being dependent on the chosen level of confidence. Our corollary that the group error for the 8 named stars equals the systematic error for area *Zod A* is also of a statistical nature and may therefore prove incorrect. Hence the question of just how much greater the discovered interval can become if the confidence areas expand indefinitely.

We shall give a "geometrical" answer to this question. Let us once again select a fixed time moment t as a candidate for the desired dating moment. After that we shall define the set D_t of such γ values that a turn of the real ecliptic by this angle for epoch t shall make the latitudinal discrepancy of all the 8 named stars conform to the 10-minute threshold with a certain value of parameter φ, qv in fig. 3.17. It is obvious that D_t contains subset S_t whatever the value of t might be. Therefore, we shall discover all the possible values of t for which the latitudes of all 8 named stars shall not differ from the respective stellar lati-


CLAVDII
PTOLEMAEI PE-
lusiensis Alexandrini omnia quæ
extant opera, præter Geographiam, quam
non dissimili forma nuperrimè ædidimus: summa cura & diligentia castigata
ab Erasmo Osualdo Schrekhenfuchsio, & ab eodem Isagoica in Al-
magestum præfatione, & fidelissimis in priores libros
annotationibus illustrata, quemadmo-
dum sequens pagina catalo-
go indicat.

BASILEÆ
Anno. 1551

Fig. 3.18. The title page from a 1551 edition of the Almagest. The handwritten dating "Anno 1551" is most noteworthy indeed; the book is likely to have been dated retrospectively, in the XVII-XVIII century.

tudes as given in the Almagest by more than 10' after a certain rotation of the ecliptic.

A most important fact is that the resultant maximal possible geometrical dating interval coincides with the interval discovered by statistical methods. See Chapter 7 for more details.

Another fact that we shall demonstrate in Chapter 7 is that the proposed dating method possesses a certain stability unaffected by the variation of the initial hypotheses, the declared precision of the catalogue, the reduction or expansion of the dating contingent of the referential stars, and also the non-linear measurement instrument distortions.

The viability of our method has also been tested on the star catalogues compiled artificially as a result of modelling random errors in stellar coordinate observations. The "observation dates" defined in modelling concur with the results of dating by our method in every case.

Apart from that, the dating method that we offer was successfully tested on several well-known old catalogues. We have used it for dating the catalogues of Ulugbek, Al-Sufi, Tycho Brahe and Hevelius. In every case the traditionally known datings of the old star catalogues under study were confirmed with our methods, the Almagest catalogue being the sole exception. This is apparently an indication that the traditional dating of Ptolemy's lifetime contains a gigantic error of several centuries or even over a millennium. See Chapter 9 for more details.

Our main corollary is as follows. The star catalogue of the Almagest was created in the interval between 600 A.D. and 1300 A.D. The Scaligerian dating of the Almagest catalogue (II century A.D.) is ipso facto proven gravely erroneous.

We shall conclude this chapter with citing the front page of a 1551 edition of the Almagest (see fig. 3.18). It is most curious that the publication date is written by hand, in the exact same place of the book's front page where one expects to find a printed date. It is possible that this date was inscribed on the book as late as the XVII or even the XVIII century, possibly with the goal of making the book seem published in the XVI century, its real publication date being much more recent.

CHAPTER 4

Who is who?

1. PRELIMINARY OBSERVATIONS

As we have seen, the dating of the Almagest by proper star movements might turn out erroneous if there was an error in identifying the fast stars used for dating as their Almagest equivalents. The problem of identifying the Almagest stars, or, more precisely, the Ptolemaic descriptions of stars, as real, or "modern" stars – the ones that we can observe today, that is, often turns out extremely complex. In some cases, there is no unambiguous solution at all. Obviously enough, we haven't been the first ones to address the problem of identifying the stars in the Almagest catalogue. This problem has been known to researchers for quite a while. However, it is of extraordinary importance to us, since no dating of the Almagest star catalogue by proper star motion rates is possible before the problem in question is solved.

Let us remind the reader that the Almagest catalogue contains 1025 stars. However, only twelve of them have names of their own in the Almagest catalogue, which use the formula "*vocatur*" (named). Those are Arcturus, Aquila (Altair), Antares, Previndemiatrix, Acelli, Procyon, Regulus, Spica, Vega = Lyra, Cappella, Canopus and Sirius (the latter is referred to as "The Hound"). No other stars but these twelve have proper names in the Almagest. They are simply described as "star at the middle of the neck", "star at the tip of the tail", "star at the end of the front leg", "the brighter of the two stars on the left knee" etc. Such descriptions are more often than not completely insufficient for a reliable identification of one Almagest star or another as its modern counterpart.

Numerous researchers of the Almagest have already performed an identification of the stars contained therein as the modern stars by comparing the Almagest star coordinates to those of the modern stars. The results of this identification can be found in the work of K. Peters and E. Knobel, for instance ([1339]). They cite a table where each Almagest star corresponds to a modern star. [1339] also contains the table of discrepancies between the identifications suggested by different researchers. However, it has to be emphasized that all prior identifications were made by astronomers who trusted the Scaligerian hypothesis, which notably affected the identification result in many cases.

Indeed, if the position of a dim and otherwise unremarkable star with a high proper motion velocity has altered notably over the period of time between the beginning of the new era and our days, it will identify as different Almagest stars in different epochs. It is pointless to date the catalogue by such stars, since

the epoch of the catalogue's compilation will be chosen depending on the chosen identification. Multiple possible identifications will lead us to multiple datings of the catalogue's compilation.

Apart from that, in this situation it is altogether impossible to be certain that the "fast" star in question is in fact included in the Almagest. Most of the stars are dim and their order of magnitude is between 4 and 6. Many of these dim stars weren't included in the Almagest catalogue for the simple reason that there are more such stars than the catalogue contains, and so there are cases when a single Almagest star can be identified as several stars visible with the naked eye. All such cases need to be taken into account so as not to base the dating method on ambiguous scenarios.

However, in general, we did not doubt the fact that the star identifications of Peters and Knobel were made diligently and in good faith ([1339]). Our computations have proved this viewpoint correct. Possible errors result from nothing but the implied incorrect dating of the Almagest star catalogue – the Scaligerian early A.D. dating. In order to rule out the effects of the Scaligerian dating, we have performed the Almagest identification of fast stars anew.

2. FORMAL SEARCH OF THE FASTEST STARS IN THE ALMAGEST CATALOGUE

2.1. The star identification method

We are only concerned with the issue of identifying the notably mobile stars in the Almagest catalogue, which may be of use for dating purposes. The faster the star, the more precisely we can date the catalogue by its position – but only given that the star in question is reliably and unambiguously identified in the catalogue that we attempt to date. In the first stage we have chosen but 78 of the fastest stars from the bright star catalogue ([1197]) in order to identify them formally as Almagest stars. Double stars are counted as a single star. The stars that we have chosen have a minimal proper movement velocity of 0.5" per year by at least one of the coordinates in the equatorial system of the epoch of 1900 A.D. It has to be said that the majority of these stars are rather dim.

A list of the fastest stars visible to the naked eye is contained in Table 4.1. This table contains the equatorial coordinates of stars for the epoch of 1900 A.D. (for the time moment of $t = 0$ in our system, and the proper motion components of star velocities rendered to the equator for the epoch of 1900 A.D. The first column of Table 4.1 contains the index of the star according to Bayer and Flamsteed. Some of the data contained in Table 4.1 were taken from the previous edition of the catalogue ([1197]). The discrepancies between the numeric values contained in both editions are minute and negligible in our case.

According to the data contained in this table, the formulae of transforming the equatorial coordinates into their ecliptic equivalents with proper star motion velocities taken into consideration (see Chapter 1) were used in order to determine the ecliptic coordinates $L_i(t)$ and $B_i(t)$ of star i on the celestial sphere $(1 \le i \le 78)$ for epoch t.

We built an estimated ε-area for each of the above 78 fast stars – in other words, a circle whose radius equals ε around the calculated position of the star on the celestial sphere for each assumed dating t between 1100 A.D. and 1900 A.D. $(0 \le t \le 30)$, see fig. 4.1. After that, we calculated the arc distance $\xi(A, i, t)$ between star A from the Almagest catalogue and the estimated position of fast modern star i, with estimated coordinates equalling $(L_i(t), B_i(t))$ in epoch t for each of the assumed dates (t).

If $\xi(A, i, t) < \varepsilon$, modern star i is likely to identify as star A from the Almagest catalogue in the moment of t. Otherwise, no such identification is likely. Thus, the identification (or "capture") only took place when area ε around the star i from the modern catalogue

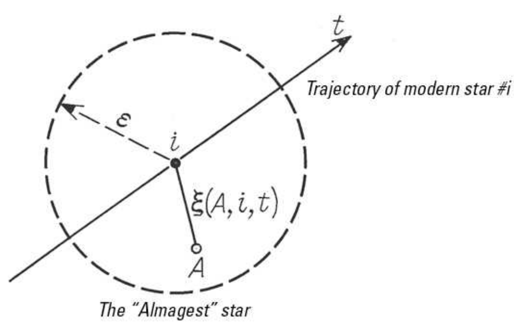


Fig. 4.1. The circular area around a modern star that moves across the celestial sphere together with the star.

Table 4.1 A list of the fastest stars in the catalogue ([1197]). We have chosen all the stars whose speed equals 0.5 sec/year minimum by at least one of the equatorial coordinates (α and δ) for the epoch of 1900.

Modern name of the star (where applicable)	*Star number in the catalogue [1197]*	α_{1900}			δ_{1900}		V_α *measurement unit 0.001"/year*	V_δ *measurement unit 0.001"/year*	*Magnitude of the star in the catalogue [1197]*
		h	*m*	*s*	°	′			
	6	00	01	08	49	38	560	-37	5,77
11 β Cas	21	00	03	50	58	36	527	-178	2,42
	77	00	14	52	65	28	1708	1163	4,34
	98	00	20	30	77	49	2223	326	2,90
	159	00	32	12	25	19	1383	-8	5,71
	173	00	35	31	24	21	640	-329	6,24
	176	00	35	44	60	01	886	451	5,79
24 η Cas	219	00	43	03	57	17	1101	-523	3,64
	222	00	43	08	4	46	752	-1142	5,82
μ Cas	321	01	01	37	54	26	3430	-1575	5,26
52 τ Cet	509	01	39	25	16	28	-1718	860	3,65
	637	02	06	19	51	19	2108	651	6,28
	660	02	10	57	33	46	1155	-240	5,07
	753	02	30	36	6	25	1807	1459	5,92
18 ι Per	937	03	01	51	49	14	1267	-81	4,17
	1006	03	15	36	62	57	1332	659	5,48
	1008	03	15	56	43	27	3056	744	4,30
	1010	03	16	02	62	53	1328	655	5,16
23 δ Eri	1136	03	38	27	10	06	-92	744	3,72
40 o^2 Eri	1325	04	10	40	-7	49	-2225	-3418	4,48
	1614	04	55	51	-5	52	557	-1089	6,50
15 λ Aur	1729	05	12	06	40	01	528	-659	4,85
	2083	05	51	44	50	24	74	568	5,00
	2102	05	53	20	63	07	135	540	4,53
9 α CMa	2491	06	40	45	16	35	-545	-1211	1,60
10 α CMi	2943	07	34	04	5	29	-706	-1030	0,48
78 β Gem	2990	07	39	12	28	16	-623	-52	1,21
	2998	07	39	51	44	55	-72	-563	5,22
	3018	07	41	51	39	59	-293	1663	5,39
	3384	08	28	57	31	11	-1119	757	6,36
	3951	09	55	15	32	25	-522	-436	5,60
	4098	10	21	54	49	19	81	-892	6,50
53 ξ UMa	4375	11	12	51	32	06	-431	-593	4,41
83 Leo	4414	11	21	42	3	33	-723	177	6,50
	4486	11	33	29	45	40	-594	18	6,39
	4523	11	41	45	39	57	-1538	393	5,04

Modern name of the star (where applicable)	Star number in the catalogue [1197]	α_{1900}			δ_{1900}		V_α measurement unit 0.001"/year	V_δ measurement unit 0.001"/year	Magnitude of the star in the catalogue [1197]
		h	m	s	°	'			
	4540	11	45	29	2	20	742	-277	3,80
5 β Vir	4550	11	47	13	38	26	3994	-5800	6,46
	4657	12	10	02	-9	44	31	-1024	6,12
	4710	12	17	51	67	05	-748	243	6,38
43 β Com	4983	13	07	12	28	23	-799	+876	4,32
	5019	13	13	10	17	45	-1075	-1076	4,80
	5072	13	23	32	14	19	-237	-583	5,16
	5183	13	42	00	6	51	-513	-114	6,32
	5189	13	43	10	35	12	-522	-178	6,47
	5209	13	45	50	23	53	-575	-310	6,48
	5568	14	51	37	20	58	1041	-1745	5,76
ν^2 *Lup*	5699	15	15	03	47	57	-1621	-275	5,71
41 γ Ser	5933	15	21	50	15	59	307	-1292	3,86
15 ρ CorB	5968	15	57	13	33	36	-200	-774	5,43
	6014	16	04	16	6	40	235	-744	6,02
	6060	16	10	11	-8	06	227	-508	5,56
26 ε Sco	6241	16	43	41	34	07	-613	-256	2,36
36 Oph	6401/2	17	09	12	26	27	-464	-1146	5,33; 5,29
	6416	17	11	28	46	32	975	213	5,58
	6426	17	12	09	34	53	1167	-176	5,89
	6458	17	16	55	32	36	126	-1047	5,36
	6518	17	25	18	67	23	-529	0	6,31
	6573	17	33	57	61	57	253	-513	5,31
46 μ Herc	6623	17	42	33	27	47	-313	-748	3,48
	6752	18	00	24	2	31	256	-1097	4,07
58 η Ser	6869	18	16	08	-2	52	-554	-697	3,26
44 χ Dra	6927	18	22	52	72	41	521	-356	3,57
	7373	19	20	12	11	44	722	640	5,16
	7644	19	55	32	67	35	845	-680	6,07
	7703	20	04	38	36	21	449	-1568	5,32
	7722	20	09	03	27	20	1244	-178	5,73
	7875	20	31	46	50	53	309	-569	5,12
3 η Cep	7957	20	43	15	61	27	91	822	3,43
61 Cyg	8085/6	21	02	25	38	15	4135	3250	5,21; 6,03
	8148	21	13	59	26	46	-539	-352	6,56
	8387	21	55	43	57	12	3940	-2555	4,59
	8697	22	47	20	9	18	522	49	5,16
	8832	23	08	28	56	37	2073	299	5,56

contained star A from the Almagest catalogue on some a priori dating interval $[t_*, t^*]$ (a fragment of the historical interval $0 \le i \le 30$). Obviously, different Almagest catalogue stars could wind up in the same area ε of the modern star i, simultaneously as well as with different t values. In some cases, the region around a fast star didn't contain any Almagest stars, regardless of the t value under consideration.

The above identification method is, of course, rather rough. In particular, it makes sense to choose values of the "capture" radius that happen to be several times greater than the error margin value of the catalogue under study. It turned out that the actual identification hardly depended on the radius values (ε) at all, owing to the fact that the stars of the Almagest are distributed across the celestial sphere rather sparsely.

2.2. The result of identifying the "modern" stars as their counterparts from the Almagest catalogue

When we were giving a general description of the Almagest catalogue, we already mentioned that the catalogue precision level as declared by the compiler equals 10' (with latitude and longitude considered individually). Hence, the arc distance measurement precision as declared in the Almagest roughly equals 14', which is $\sqrt{2}$ times lower than the individual measurement precision for each coordinate. However, this declared precision happens to represent a record value of sorts, that is, such precision can only be attained for well-measured stars – such as the named basis ones. Real precision might well prove to be several times lower.

We shall consider the precision issues in more detail below (Chapters 5 and 6). For the meantime, we can safely leave the topic alone and choose such a value for the capture radius ε that will be several times greater than 14'. This is exactly what was done, namely, we chose the values for ε to equal (½)°, 1°, (1½)°, 2°. Table 4.2 contains the fast star identification results for the abovementioned time interval of $0 \le t \le 30$ – between 1100 B.C. and 1900 A.D., that is. The only fast stars that we find in this table are the ones whose environs "capture" at least one star from the Almagest catalogue with a minimum of one t for the indicated values of ε.

Each of the table's rows corresponds to a pair of identified stars – the "fast modern star" whose number is taken from the catalogue ([1197]), and the Almagest star which we shall mark as A. If the "fast modern star" isn't identified as the Almagest star A whatever the value of ε – that is to say, if the Almagest star A isn't captured by the ε circumference of the "fast modern star" in question, we put a dash into the respective position in the table. For instance, star 1325 from [1197] cannot be identified as Bailey's star #780 from the Almagest anywhere on the historical interval $0 \le t \le 30$ with $\varepsilon = 0.5°$.

If a star numbered i is just identified with a single star A from the Almagest catalogue, what we indicate in the respective row is Bailey's number of star A, as well as the time intervals for which the identification takes place with different values of ε. Star whose i value equals 21 (11 β Cas, that is) can thus be identified as the star $A = 189$ with $20 \le t \le 30$, if $\varepsilon = 0.5°$ and on the entire interval of $0 \le t \le 30$ if $\varepsilon \ge 1°$.

Should star i have several identification options, all of them are indicated in the corresponding row, and the time interval that we regard is the one for which the Almagest catalogue star under study is closer to star i than other stars that it may be identified as. The star with $i = 1325$, for instance, or 40 o^2 Eri, can be identified as different Almagest stars on different time intervals (numbers 778, 779 and 780 in Bailey's numeration). The column that corresponds to the value $\varepsilon = 1.5°$ tells us that while $0 \le t \le 10$, star $i = 1325$ is the closest to Almagest star $A = 780$ (in Bailey's numeration). Nevertheless, let us note that if $t = 10$, the distance between the stars $i = 1325$ and $A = 779$ is also less than 1.5°.

The reason for identifying the modern stat i as the Almagest star A for the moment t is as follows. If one is to assume that the Almagest catalogue was compiled in year t, the most fitting "candidate" for playing the part of A-numbered star from the catalogue is the i-numbered star from the modern catalogue ([1197]).

Table 4.2 demonstrates that the choice of the ε value hardly affects the identification results at all. This choice is arbitrary in many respects, and is only dictated by the following informal considerations. Firstly, the radius of ε must be comparable to the actual catalogue precision level. Secondly, it has to be sufficiently big for the identified pair list to contain

Table 4.2. Time intervals of possible identifications of the fastest stars as their Almagest counterparts for varying inclusion range values of ε. Alleged dating parameter t *has values that fluctuate between 0 and 30, which correspond to the changing alleged Almagest catalogue creation dating interval beginning with 1900 A.D. and stretching backwards in time with a step of 100 years. The value of* t = 0 *corresponds to 1900 A.D.;* t = 30 *corresponds to 1100 B.C.*

Number of the star in the star catalogue [1197]	*Number of the star in the Almagest star catalogue*	*Time intervals of fast star identification for varying inclusion range values of ε. We indicate intervals applicable to the alleged dating parameter* t*, which fluctuates between 0 and 30*			
		ε = *0.5°*	ε = *1.0°*	ε = *1.5°*	ε = *2.0°*
21	189	[20.30]	[0.30]	[0.30]	[0.30]
219	180	–	[0.30]	[0.30]	[0.30]
321	185	–	[6.27]	[0.30]	[0.30]
509	723	[4.30]	[0.30]	[0.30]	[0.30]
660	360	[8.30]	[8.30]	[8.30]	[8.30]
–//–	361	[0.7]	[0.7]	[0.7]	[0.7]
753	716	–	[10.30]	[2.30]	[0.30]
937	196	[27.30]	[0.30]	[0.30]	[0.30]
1136	783	[0.13]	[0.30]	[0.30]	[0.30]
1325	778	[29.30]	[29.30]	[29.30]	[29.30]
–//–	779	[19.25]	[14.28]	[12.28]	[12.28]
–//–	780	–	[0.8]	[0.11]	[0.11]
1614	775	–	–	[0.30]	[0.30]
1943	848	[0.17]	[0.30]	[0.30]	[0.30]
2491	818	[8.30]	[0.30]	[0.30]	[0.30]
2990	425	[0.30]	[0.30]	[0.30]	[0.30]
2998	882	[0.30]	[0.30]	[0.30]	[0.30]
4375	32	[0.3]	[0.30]	[0.30]	[0.30]
4414	486	[0.30]	[0.30]	[0.30]	[0.30]
4540	501	–	[14.30]	[0.30]	[0.30]
4657	732	–	–	[0.30]	[0.30]
5019	527	[8.30]	[0.30]	[0.30]	[0.30]
5188	935	–	–	[0.30]	[0.30]
5288	940	–	[0.21]	[0.30]	[0.30]
5340	110	[5.13]	[0.25]	[0.30]	[0.30]
5460	969	–	–	–	[0.30]
5699	979	[0.25]	[0.30]	[0.30]	[0.30]
5933	265	–	[8.30]	[0.30]	[0.30]
6241	557	[0.30]	[0.30]	[0.30]	[0.30]
6401	247	[17.30]	[0.30]	[0.30]	[0.30]
6623	125	–	[0.30]	[0.30]	[0.30]
6752	261	–	[4.30]	[0.30]	[0.30]
6869	279	[0.28]	[0.30]	[0.30]	[0.30]
7957	79	–	[0.22]	[0.30]	[0.30]
8085	169	–	–	[22.30]	[20.30]
8697	327	–	–	[0.7]	[0.7]
–//–	328	[28.30]	[8.30]	[8.30]	[8.30]

something in the first place; end result should not be affected by the possible aberrations contained in the catalogue. Thirdly, the value of ε should not be excessive to keep the identification result definite.

In particular, table 4.2 shows us that 36 out of the 78 stars under study could be identified. These identifications do not contradict the ones indicated in [1339]. Moreover, the overwhelming majority of them coincides with the previously known identifications. The visible exception is the star whose *i* number equals 1325, or o^2 Eri. The work of Peters and Knobel points out the dubiety of this star's identification. Our research demonstrates that it can be identified as different stars of the Almagest on different time intervals. Bearing in mind its rather low luminosity, the identification of the Almagest stars $A = 778$, 779 and 780 as real celestial objects is highly dubious. Therefore we have to exclude these three stars from further consideration, which we have already done.

Table 4.2 contains an example of the opposite as well. For instance, the Almagest catalogue star $A = 169$ in Bailey's numeration became identified as two modern stars simultaneously (#8085 and #8086 in the modern catalogue – [1197]).

The results presented in table 4.2 tell us that new identifications of stars are an exception and not the rule. This is explained by the low mobility of the overwhelming majority of the stars as well as the fact that the stars from the Almagest catalogue are at a significant distance from each other on the celestial sphere. The stars that we shall base our research upon were not re-identified; we shall therefore use their corresponding numbers in Bailey's numeration without quoting the numbers of [1197]. The star will be named should such a necessity arise.

The table that we cite might lead one to the question of whether one can use the resultant time intervals for fast star identification in the Almagest in order to date the latter. It appears that no reliable dating can be calculated in this manner. The reasons are discussed above in great detail (see Chapter 3).

We feel we should sum up with the general observation that if one were to exclude the ambiguously identified stars from the list and make ε equal some minimal value which would make all the identification intervals intersect with each other, this ε value could serve the ends of evaluating the real fast star measurement precision, the intersection point being the approximate date of the catalogue's creation. However, table 4.2 demonstrates that the value of ε that we get in such a manner is too great. It will take several millennia for this distance to be covered – even by the fastest of stars. However, in this case the date in question will be determined very unreliably, with a possible millenarian aberration. In particular, a dating like this shall be largely dependent on the stellar contingent under study. Adding or subtracting a single star, for instance, can significantly affect the dating. This is exactly why we describe the stage of classifying stars by the precision of their measurement separately in Chapter 3 for – it is a necessary procedure required for a reliable dating.

2.3. Corollaries

Corollary 1. Most of the stars in the Almagest catalogue were identified correctly by the researchers that preceded us.

Corollary 2. Out of the 78 fastest stars borrowed from a modern bright star catalogue ([1197]) and visible to the naked eye, 36 stars can be reliably identified as Almagest stars (see table 4.2).

Corollary 3. Only the following fast stars from table 4.2 are identified ambiguously with ε = 1.5°.

a) Star o^2 from the constellation of Eridanus = 40 o^2 Eri, numbered 1325 in [1197] can be identified as the following Almagest stars (in Bailey's numeration, for different alleged epochs).

Almagest star 778 for the interval of 1100 B.C. – 800 B.C.;

Almagest star 779 for the interval of 700 B.C. – 800 A.D.;

Almagest star 780 for the interval between 900 A.D. and the present epoch.

b) Star 660 from [1197] can be identified as the following Almagest stars:

Almagest star 360 for the interval of 1800-1900 A.D.;

Almagest star 361 before 1800 A.D.

c) Star 8697 from [1197] can be identified as two Almagest stars in different epochs:

Almagest star 327 for the interval of 1200 A.D. – 1900 A.D.;

Almagest star 328 before 1200 A.D.

3.
THE SEARCH OF ALL THE FAST STARS RELIABLY IDENTIFIABLE IN THE ALMAGEST CATALOGUE

In the previous section we were looking for possible identifications of fast stars seen with the naked eye as the Almagest stars. This would allow us to instantly reject the stars which are a priori useless for a proper movement dating of the Almagest due to the fact that the possible identification of these stars as their counterparts from the Almagest is largely dependent on the alleged dating.

Let us now ask an altogether different question – which ones of the relatively fast modern stars can be identified in the Almagest catalogue with absolute precision? The search of these stars is the necessary preliminary work that has to be done before we can date the catalogue by proper star movements. This formulation of the problem differs from the one offered in the previous section. Before we have used a rough formal method for the rejection of the stars which obviously cannot be identified as the Almagest stars reliably. As a result, many of the "poorly qualified" stars were not excluded from our research. However, we shall be needing a meticulously verified list of fast stars which can be reliably identified in the Almagest. This task requires some additional work from our part, and we'll get right to it.

In order to solve the problem, we have taken the modern electronic version of the catalogue BS5 which contains all the stars visible to a naked eye – about nine thousand of them altogether. Catalogue BS5 is a more precise version of the bright star catalogue BS4 ([1197]). We have checked the electronic version of BS5 for misprints having compared it to the printed edition of BS4 ([1197]). All the misprints were corrected.

Step 1. Selecting the stars for speed.

We have picked out all the stars from the catalogue BS5 whose annual proper movement speed equals 0.1 sec (by one of the coordinates in the equatorial system for the epoch of 1900). These speeds were taken from the printed catalogue BS4 ([1197]), since in the catalogue BS5 the speeds are given in equatorial coordinates for the epoch of 1900 A.D. Let us remind the reader that the coordinate system choice of one epoch or another by no means implies that the star positions were calculated for the same epoch. These phenomena are not related in any way at all.

Step 2. Selecting the stars that have either Bayer's or Flamsteed's indications.

Further one, we have picked out just those stars whose indication either included a "Bayer's letter" or a "Flamsteed's number", or both. We have already mentioned our motivation for doing this above. The reason is that the systems of Bayer and Flamsteed are the XVII-XVIII century heirs of Ptolemy's stellar position description method which would describe the star's relative position in a given constellation verbally. It would be natural to assume that when these astronomers introduced a new system of indicating stellar positions, they studied the Almagest very pedantically, ascribing their new indication to a star whose identification would leave no place for doubt. Had we kept back the stars which neither have Bayer's letter nor Flamsteed's number in their name, it would mean that we're keeping back the stars that Bayer and Flamsteed were doubtful about. And what we seek to evade first and foremost is the effect of the "suspicious stars" that can lead us to erroneous datings based upon false identifications.

Why have we chosen Bayer and Flamsteed in particular – from the great multitude of later astronomers of the XVII-XX century who studied the Almagest? This was primarily caused by the fact that they were the ones to introduce the new indications of stars which reflected the old tradition that they were based upon. The generations of astronomers that followed them were already using the new indication for their studies, and the old tradition had soon been forgotten as obsolete. Metaphorically speaking, the astronomy teacher of Bayer could point out the stars on the sky (and then the respective places in the Almagest describing said stars) with his finger, quoting their names as given by Ptolemy – "the star on Virgo's shoulder", "the star on the hoof of Pegasus" etc. The following generations of young astronomers would already learn the names of these stars as "the Delta of Virgo", "the Epsilon of Pegasus" and so on. The Almagest catalogue terminology became completely obsolete.

Step 3. The selection of stars which have old names of their own.

The catalogue BS4 ([1197]) contains the complete list of "Star names found in old and more recent texts" on pages 461-468. The texts in question date back to the "antiquity" and the Middle Ages. We cite this entire list in tables P1.2(a) and P1.2(b) in Annex 1. We have picked out those of the stars we ended up with in the previous stage which can be found in this list of old stars possessing names of their own.

The reasons for such a selection are as follows. We want to exclude all possible errors in our identification of the stars which shall be used for the dating of the Almagest. It is obvious that if a star has a mediaeval name of its own, it makes its identification more reliable. Named stars have clearly been of special interest for the old astronomers, hence the very fact of their having names. Since old astronomy was based on the Almagest to a great extent, one is to expect that these stars could be identified in the Almagest more reliably than others.

Step 4. The selection of stars that fall into the "well-measured celestial areas" of the Almagest.

We proceeded to exclude the stars which wound up in celestial areas *C* and *D* of the Almagest catalogue. We shall explain the reason for that in Chapter 6. These are the areas for which we can neither calculate nor compensate the systematic error of the Almagest compiler. Apart from that, our analysis of Ptolemy's measurement precision for different areas of the sky (see Chapter 2) demonstrates areas *C* and *D* to be the "worst-measured" in the Almagest. The implication is that even if the position of a star is measured well enough but falls into one of these areas, the error in its coordinates can substantially affect the proper movement dating, making it extremely imprecise.

Having performed the selection described above, we ended up with a total of 76 stars.

Step 5. Selecting the stars by the local star chart image.

In the final stage we have chosen only those stars which can be unequivocally located on the sky by Ptolemy's coordinates, even if one is to allow for the gigantic errors of 2-3 degrees. We have meticulously verified the correctness of luminosity as stated in the Almagest, as well as the veracity of Ptolemy's description. If any discrepancies were found, the star would be rejected at once.

As a result, the only stars that we decided to keep in our list were the ones which can be isolated among the stars of comparable luminosity and also correspond to the coordinates of a single star in the Almagest that cannot be identified as any other star even if we are to allow for an aberration of several degrees. We have used the star atlas ([293]), as well as the simple and convenient software package called Turbo-Sky which can display a detailed map of any given celestial area accounting for stellar luminosity. This program also includes a "telescope" feature giving a 25x zoom.

During this last selection stage 8 stars of 76 were rejected, which leaves us with 68 stars. The rejected 8 stars are listed in table 4.3.

Table 4.3. Eight stars rejected in the final stage of "filtration" of the 76-star list.

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
BS5	*Name*	*?*	M_{BS5}	$\nu_{\alpha 1900}$	$\nu_{\delta 1900}$	*Bailey's number*	M_A
921	25ρ Per		3.39	+0.130	–0.102	204	4
2484	31ξ Gem		3.36	–0.115	–0.194	441	4
4057	41γ^1 Leo		2.61	+0.307	–0.151	467	2
6913	22λ Sgr		2.81	–0.043	–0.185	573	3
8610	63κ Aqr		5.03	–0.070	–0.114	651	4
321	30μ Cas	D	5.17	+3.423	–1.575	185	4
343	33θ Cas	D	4.33	+0.229	–0.017	185?	5
7348	α Sgr	D	3.97	+0.030	–0.121	593	2-3

The first column of table 4.3 contains the star's number according to the bright star catalogue BS5. The second column contains the name of the star. In the third column we find the letter *D* which stands for "disagreement" (referring to different researcher versions) which we borrowed from the electronic version of the Almagest. The corresponding explanatory materials tell us that the discrepancies between the opinions of various astronomers are quoted according to [1478]. The book also accounts for the discrepancies pointed out by Peters and Knobel ([1339]). The fourth column contains Bailey's numeration, or the Almagest number given to the suggested doppelganger of the star in question. The eighth column contains the luminosity value according to Ptolemy.

We must emphasize that the previous list of 76 stars contained a total of three dubiously-identifiable stars according to [1478]. The stars we are referring to are marked *D* (for dubiously-identifiable). All three stars were discarded in the final "filtering" of our list.

To size up, we could say that we got a list of stars which can be identified as their Almagest counterparts reliably and whose proper movement is visible from celestial areas *A*, *Zod A*, *B*, *Zod B* and *M*. The list contains a total of 68 stars; it can be seen in table 4.4 from Annex 1 at the end of the book.

Let us emphasize that the resultant list contains the complete "kernel" of the eight named Almagest stars which we already mentioned above. These eight stars are collected in the very beginning of the list and marked with block letters. This is the primary list we shall use in our final dating of the Almagest catalogue by proper star movements.

CHAPTER 5

The analysis of the star catalogues' systematic errors

0. BASIC CONCEPTION

0.1. A demonstrative analogy

The necessity of analyzing the errors contained in star catalogues was already explained above. First and foremost, we are referring to the Almagest; however, the method in question shall also be applied to other catalogues – real ones as well as artificially generated ones. In the present chapter we shall demonstrate how to discover and compensate the systematic error. The idea behind the method is simple and quite natural. Moreover, it has been used in mathematical statistics for quite a while now. In order to explain the basic concept, let us consider the following example. Let us assume that we are regarding the results of a shooting competition as shown on the picture.

The dots represent bullet holes. How great is the hit accuracy? The answer is obvious – not that great at all. However, we can see that the actual grouping of shots is good enough. This leads us to the assumption that the rifleman is in fact a good one; as for the fact, that the bullets hit a spot which lies sideways from the bull's eye, it can be explained by a defect in his rifle-sight. Obviously, we can say nothing about the nature of said defect without seeing the rifle – however, we can estimate the displacement value. A sensible way of doing this would require us to determine the geometrical centre of all the results and draw a vector from the bull's eye to the calculated centre (vector S on the scheme). How do we formally calculate vector S? The procedure is a simple one. We have to take vectors x_i which correspond to the i^{th} result of the shooting and to average them by the total amount of shots N:

$$S = \frac{1}{N}\sum_{i=1}^{N} x_i .$$

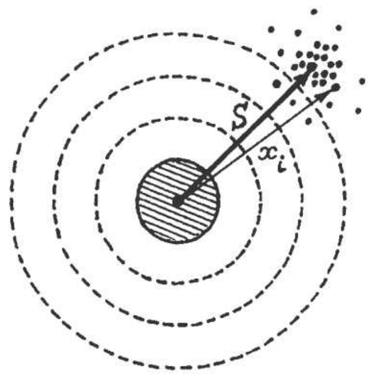


Fig. 5.0. A target with traces of bullet shots.

We must also point out that vector S can be calculated alternatively from the problem of square average discrepancy minimization – we have to find vector S which provides for the minimum of the function

$$\sum_{i=1}^{N}(x_i - S)^2.$$

Here we estimate that $(x_i - S)^2 = (x_{i1} - S_1)^2 + (x_{i2} - S_2)^2$, where x_{i1}, x_{i2} and S_1, S_2 are the respective coordinates of vectors x_i and S.

The accuracy of the actual rifleman can then be characterized by the result scatter range around the discovered centre; this accuracy is thus a lot greater than the accuracy of hitting the bull's eye. The calculation of vector S represents the actual systematic error compensation procedure for this example (whose value equals S, respectively).

Formally, if we are to use a different coordinate system moving its initial point sideways from the bull's eye by vector S, the shooting results as given in the new coordinate system shall only contain random compounds (resulting from shaking hands etc), with no regular compound.

Let us now return to the star catalogue and assume that we need to check whether there may be a systematic error in some part of the catalogue and to determine its value should such an error indeed exist. Let us assume that we aren't confronted by the problem of dating so far – that is to say, we know the date when catalogue t_A was compiled for certain (A is for Almagest, of course – still, all the above considerations are valid for other catalogues as well). We would then have to compare the real coordinates of the stars for the moment t_A (known from precise modern catalogues) to the coordinate values taken from the catalogue under study which pertain to the part thereof that is used in our research. This comparison requires the calculation of the average discrepancy rate for the coordinates under comparison, just like we did in the example with rifle shot accuracy.

Let the total of stars from the chosen area equal N. We shall use the indications l_i and L_i for the actual ecliptic longitude of star i in the catalogue under study and its exact longitudinal value, respectively. In this case, the average (systematic) longitude error shall equal

$$\Delta\overline{L} = \frac{1}{N}\sum_{i=1}^{N}(l_i - L_i),$$

with the systematic latitudinal error equalling

$$\Delta\overline{B} = \frac{1}{N}\sum_{i=1}^{N}(b_i - B_i).$$

These errors, as we already mentioned, may result from the incorrect estimation of the ecliptic plane as well as a number of other reasons which remain unknown to us. We shall not be able to say anything in re the exact nature of these circumstances – however, we shall put forth a number of hypotheses in this respect. All of this notwithstanding, we can, and will, compensate the error that they caused. It requires nothing but the alteration of the catalogue coordinate system similarly to how it was done in the rifle example – one that would make the resultant average longitudinal and latitudinal errors equal zero.

0.2. The implementation of the method

In this section we shall demonstrate the practical application of the general concept related above.

First of all, let us emphasize that we shall only compensate the latitudinal error. The reasons were all named above – basically, it allows to minimize the error in calculations, which is vital, considering the low precision of the old catalogues.

Thus, what we have at our disposal is the catalogue from which we have selected a large group of stars whose total number equals N, with the coordinates $(l_i, b_i)_{i=1}^{N}$. Their doubles from the modern catalogue are already known to us from the previously conducted identification procedure. Let us use the indications $(L_i(t), B_i(t))_{i=1}^{N}$ for referring to the coordinates of said doubles calculated for moment t. Let us now assume that we want to examine the possible systematic error value under the assumption that the catalogue compilation date is t_A.

Let us define

$$L_i^A = L_i(t_A),\ B_i^A = B_i(t_A)$$

and introduce the latitudinal discrepancy

$$\Delta B_i^A = B_i^A - b_i.$$

Our goal is to minimize the value of

$$\sigma^2 = \sum_{i=1}^{N} (\Delta B_i^A)^2 \longrightarrow \sigma^2_{\min},$$

by changing the coordinate system, or simply drawing a new coordinate grid that differs from the one used in the catalogue.

The change of the coordinate grid can be parameterised by two values if we are to consider the problem of minimizing the expression mentioned above: γ and φ. They can be seen in fig. 5.1 below. Let us explain what they stand for. Here γ is the angle between the real ecliptic and the ecliptic of the catalogue, whereas φ represents the angle between the equinox line and the line of intersection between the real ecliptic and the catalogue ecliptic.

Thus, having solved the problem of minimizing the abovementioned expression, we can calculate the values of γ_{stat} and φ_{stat} which can parameterise the coordinate system alteration and give us the initial minimum. Their explicit form can be seen below, in formulae 5.5.2 and 5.5.3.

The value of σ_{min} is a residual square average latitudinal error that we end up after the compensation of the systematic error. The explicit form of the residual dispersion formula σ_{min} can be seen below, after formula 5.5.10. It results from using γ_{stat} and φ_{stat} as the parameters for the square average aberration expression. The derivation of these formulae can be seen below.

However, we cannot presume to have found the systematic error (or, rather, the parameters γ_{stat} and φ_{stat} that characterize it) with absolute precision. The matter is that individual measurement errors (which are of a random nature) also affect the values of γ_{stat} and φ_{stat}. Therefore, we can only claim that the real values of the systematic error are close to γ_{stat} and φ_{stat}.

In order to make our statement more precise, let us introduce the concept of a "trusted interval". Let 1-ε stand for a certain level of trust. If $\varepsilon = 0.1$, for instance, the level of trust shall equal 0.9. The level of trust represents the probability that guarantees the precision of our results; the trusted interval is the interval that includes the unknown real value of the parameter with a minimal probability of 1-ε. Let us define

$$I_\gamma(\varepsilon) = [\gamma_{stat} - x_\varepsilon, \gamma_{stat} + x_\varepsilon]$$

(or the trusted interval for the real value of parameter γ), and

$$I_\varphi(\varepsilon) = [\varphi_{stat} - y_\varepsilon, \varphi_{stat} + y_\varepsilon]$$

which is the trusted interval for the real value of the parameter φ. It can be demonstrated (qv below) that the values of x_ε and y_ε can be calculated by the formulae

$$x_\varepsilon = q_\varepsilon, y_\varepsilon = q_\varepsilon,$$

where q_ε represents $(1-\frac{\varepsilon}{2})$ – the fractile of the standard normal distribution as calculated from the tables.

Thus, if we are to define a certain confidence level 1-ε, we can guarantee that the real value of γ falls into the interval $I_\gamma(\varepsilon)$, and the value of φ falls into the interval $I_\varphi(\varepsilon)$ with a probability of no less than 1-ε.

0.3. The value of the systematic error cannot be used for the dating of the catalogue

Let us now provide a somewhat different interpretation of the calculated values of γ_{stat} and φ_{stat}. The use of stellar coordinates (it suffices to consider nothing but the latitudes, as a matter of fact) permits an easy calculation of the ecliptic poles P_A (for the catalogue under study) and $P(t)$ for the calculation catalogue of the moment t, qv in the diagram.

It is obvious that the arc distance between P_A and $P(t)$ equals γ_{stat} precisely, and that the compensation

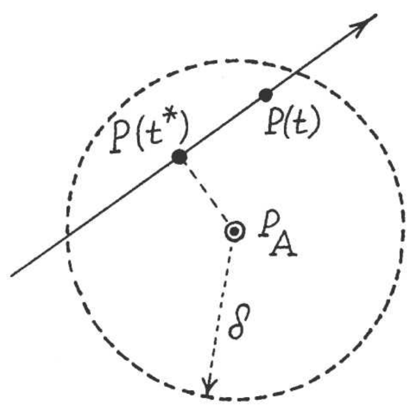


Fig. 5.0a. The two poles – on the ecliptic and in the catalogue.

of the systematic error requires nothing but the superposition of these two poles. Let us now consider the changes in the general picture that take place over the course of time. Since $P(t)$ shifts within the limits of one degree, we can use a flat diagram and assume that the motion of $P(t)$ is uniform, qv in the diagram.

Velocity v of this uniform motion is easy enough to calculate if we know the values of γ_{stat} for two different points. We can then calculate the moment t^* when the position of the real pole is the closest to that of the catalogue pole. Prima facie we might assume that this moment can be declared as the dating moment deduced from processing the coordinates of a great many stars. However, we have already demonstrated the fallacy of such logic; therefore, it has to be said that one cannot date the catalogue to the moment of t^*. Indeed, if the possible systematic error in Ptolemy's estimation of the ecliptic can equal the value of δ, all the moments in time that correspond to the passage of the pole $P(t)$ through a circle with the radius equalling δ whose centre lays in the point P_A should be regarded as possible candidates for the moment of dating. However, we do not know the value of δ. We can naturally estimate it, but only given that we know the dating of the catalogue. A different presumed dating shall yield a different estimation value. Therefore, this value already contains the presumed dating.

Thus, depending on Ptolemy's systematic error, or the error in the determination of the ecliptic, the moment t^* can either precede the real date of the catalogue's compilation or postdate it. In the former case, the catalogue (or, rather, the part of it for which we are trying to estimate the value of γ_{stat}), gains "extra age", beginning to resemble a catalogue compiled in the year t^*. In the latter case (when t^* postdates the real compilation dating) the catalogue becomes more recent. Below we shall see that both these possibilities are implemented in the Almagest. However, the terms "extra age" and "more recent" refer to a catalogue where the systematic errors were not compensated. What we end up with after the compensation is a "refined catalogue" which only contains random errors whose square average value can be estimated to equal σ_{min}, although no individual value can be determined.

Let us now consider the practical use of the general idea as specified above in more detail.

1. MAIN DEFINITION

From this chapter and on we shall assume to be dealing with a catalogue whose every star has a single double among the stars of the modern catalogue. Accordingly, we shall be using index i in order to identify the stars, as well as l_i and b_i for the ecliptic longitude and latitude of star i in the Almagest, respectively. $L_i(t)$ and $B_i(t)$ shall be used for referring to the real longitude and latitude of star i in epoch t. Bear in mind that time t is calculated backwards from 1900 A.D. and measured in centuries – that is to say, $t = 3.15$ shall correspond to the year $1900 - 3.15 \times 100 = 1585$ A.D., for instance, and $t = 22.0$ shall correspond to the year $1900 - 22 \times 100 = 300$ B.C.

Let t_A equal the unknown time of the Almagest catalogue compilation. The real longitude and latitude of star i for the year when the catalogue was compiled shall be indicated as L_i^A and B_i^A – that is, $L_i^A = L_i(t_A)$, $B_i^A = B_i(t_A)$. Let $\Delta B_i(t) = B_i(t) - b_i$ stand for the difference between the real latitude of star i for moment t and its latitude as given in the Almagest. The value of $\Delta B_i(t)$ shall be referred to as the latitudinal discrepancy for moment t. This value shall stand for the error in the estimation of the latitude of the Almagest star i under the condition that it was compiled in epoch t. It is natural that the real error in the estimation of the latitude is represented by $\Delta B_i(t_A) = \Delta B_i^A$.

As we already pointed out in Chapter 3, we only have to analyze the latitudinal errors in the case of the Almagest. The reasons for this were explained in detail above.

2. THE PARAMETERISATION OF GROUP ERRORS AND SYSTEMATIC ERRORS

Let us consider a certain group of stars such as a constellation or several constellations. We shall define the group error in the latitudinal coordinates of these stars as the error in the estimation of stellar latitudes for the group in question resulting from the motion of the stellar configuration under study across the celestial sphere as a whole. Therefore (we shall put a special emphasis on this circumstance due to its extensive use below), any subset of this configuration

also shifts across the celestial sphere as a whole with the same angle as the entire configuration. Such shifts have three degrees of freedom – that is, they can be described by the specification of three parameters which we shall shortly define.

In fig. 5.1 one sees a diagram of the above. The position of the real ecliptic for the time moment t_A is represented on the celestial sphere whose centre is in point O. The respective points of the vernal and autumnal equinoxes are marked Q and R on the ecliptic. Point P represents North Pole of ecliptics. Point E represents the position of a given star. As we have already mentioned, all the group errors for a fixed stellar group in the ecliptic latitude made by the compiler of the catalogue can be considered to stem from the miscalculation of the ecliptic pole without exception, or the result of the fact that the compiler used the wrong point for the pole – P_A instead of P.

This point corresponds to the perturbed ecliptic which is referred to as the catalogue ecliptic in fig. 5.1. Its position can be determined in a unique way after we determine the following two parameters – firstly, angle γ between the lines OP and OP_A, or the very same plane angle between the planes of the real ecliptic and the catalogue ecliptic. Secondly, we must calculate angle φ between the equinox line RQ and line CD that results from the intersection of the real ecliptic plane with that of the catalogue ecliptic. This parameterisation is convenient for analytic purposes. However, we shall also be using value β alongside φ, which can be interpreted as follows (see fig. 5.1). The shift of the ecliptic can be decomposed into the composition of two rotations – one around the equinox axis RQ equalling angle γ, and the other around the axis that also lies within the plane of the ecliptic and is perpendicular to axis RQ and equals angle β. Thus, β stands for the length of arc Q_AQ which pertains to the large circumference that goes through pole P_A and point Q. The astronomical meaning of the point Q_A is clear enough. It is the vernal equinox point on the ecliptic of the catalogue. It is obvious that angles γ and φ unambiguously define the angles γ and β; the reverse is also true. The desired relation can be determined from the consideration of a spherical right-angled triangle CQ_AQ. The angle at the vertex Q_A is a right one, the angle at the vertex C equals γ, and the length of arc CQ equals β. The result is as follows:

$$\sin\beta = \sin\gamma \sin\varphi \qquad (5.2.1)$$

The third degree of freedom is defined by the rotation of the sphere around the axis $P_AP'_A$, qv in fig. 5.1. However, this rotation only affects stellar longitudes, leaving their latitudes intact. Therefore, we shall not be considering this degree of freedom. Let us point out that instead of the parameters specified we could choose any other set of basis parameters that define the rotation of the sphere. This obviously cannot affect the further conceptual development of our method.

Let us now study the distortion of the real coordinates of star i as affected by the systematic error of this kind. The real latitude B_i^A and the latitude of this star L_i^A are equal to the lengths of arcs EE' and QE' counted clockwise as seen from pole P, respectively. The respective distorted latitude and longitude b_i and l_i equal the lengths of arc EE_A and Q_AE_A. Bear in mind that the latitudes of stars whose real longitudes are greater than the latitude of point D and smaller than that of point C are reduced, whereas other latitudes increase, qv in fig. 5.1. This corollary does not apply to all stars, strictly speaking. It is false for the stars located at the angle distance of γ or less from the poles P and P'. However, since the value of γ is anything but great, there are very few stars which can be found in

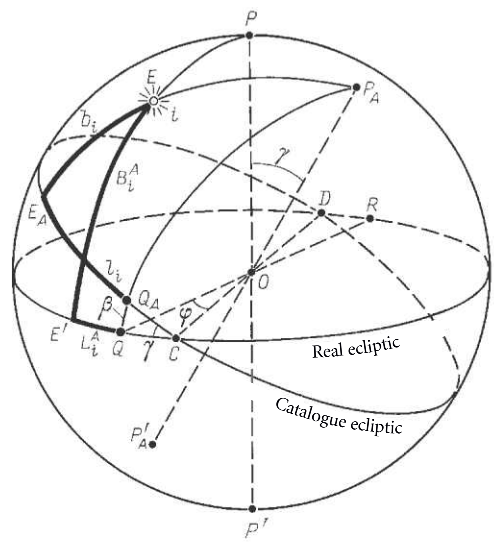


Fig. 5.1. Parameters defining the systematic error.

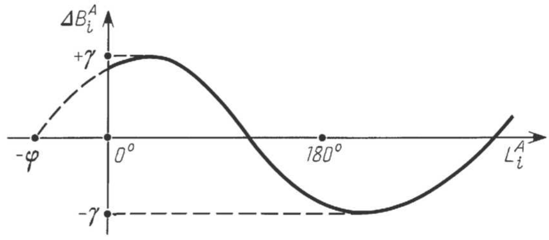


Fig. 5.2. The dependency between the systematic latitudinal discrepancy and the longitude.

such a small area. Virtually none of those are contained in the Almagest catalogue. As we shall see, the value of γ equals circa 20'.

Bearing in mind the value of γ being minute, one can suggest the following approximated formula for the latitudinal discrepancy:

$$\Delta B_i^A = \gamma \cdot \sin(L_i^A + \varphi). \qquad (5.2.2)$$

In other words, the systematic error in stellar latitude estimation can be represented with the sine curve we see in fig. 5.2. It is very much like the curve discovered earlier by Peters and Knobel ([1339]) when they were processing the data from the Almagest catalogue. The error rate of formula 5.5.2 does not exceed 1' for the stars whose $|b_A| \leq 80°$ and is therefore of no importance to us, so we shall consider the formula 5.2.1 absolutely precise. For the sake of propriety we shall exclude the stars whose absolute latitudinal values exceed 80 degrees from further consideration. We shall refer to the systematic error hereinafter, since the methods described are only valid under the assumption that we are considering a large group of stars. The verification of whether or not the discovered discrepancy coincides with group errors for individual constellations is a problem in itself. Its application to the Almagest is considered below, in Chapter 6.

Assuming that the time t_A of the catalogue's compilation is known, we can calculate the parameters γ and φ which define the systematic error as follows:

1) We shall calculate the real latitudes B_i^A and longitudes L_i^A for all the stars from the group under consideration (corresponding to the moment t_A).

2) Then we must find the values of parameters γ^* and φ^* which lead us to the solution of the problem in question.

$$\sigma^2(\gamma^*, \varphi^*) \to \min, \qquad (5.2.3)$$

where

$$\sigma^2\ (\gamma, \varphi) = \sum (B_i^A - b_i - \gamma \sin(L_i^A + \varphi))^2.$$

Had there been no other errors in the catalogue except for the systematic ones, the relation 5.2.3 would transform into the equation $\sigma^2(\gamma^*, \varphi^*) = 0$. However, the presence of random errors in stellar coordinates makes the minimum of 5.2.3 differ from zero.

In our situation, the catalogue compilation moment t_A remains unknown; therefore, we must calculate the systematic errors for all possible values of t from the interval $0 \leq t \leq 25$ under study, namely, the position of the real ecliptic and the equinox axis are calculated for every value of t. Then, just as we see it in fig. 5.1, the parameters $\gamma = \gamma(t)$, $\varphi = \varphi(t)$ and $\beta = \beta(t)$ are introduced; they define the relative positions of the catalogue ecliptic and the ecliptic for epoch t. The values of $\gamma(t)$ and $\varphi(t)$ are found as the solution of the problem

$$\sigma^2(\gamma(t), \varphi(t), t) \to \min, \qquad (5.2.4)$$

where

$$\sigma^2(\gamma, \varphi, t) = \sum (\Delta B_i(t) - \gamma \sin(L_i(t) + \varphi))^2. \quad (5.2.5)$$

Once again, had this case been ideal (with no other discrepancies but the systematic error inherent in the catalogue), the relation 5.2.4 could be transcribed as the following equation (disregarding the minute effects of proper star movement): $\sigma^2(\gamma(t), \varphi(t), t) = 0$.

As for the proper movement effects, let us remind the reader that the quantity of visibly mobile stars on the celestial sphere is very small as compared to the entire number of the Almagest stars. The solution of this last equation would exist for all the values of t; however, these equations would not enable us to calculate the date of t_A. It is all the more impossible to calculate it from the relation 5.2.4 which acts as a substitute for the equation in question when we con-

sider a real catalogue containing random errors. We can merely calculate the systematic error as a function of the alleged dating t. This error is naturally dependent on the presumed dating due to the fluctuation of the ecliptic over the course of time. It is precisely why we aren't referring to the dating of the catalogue, but rather the deduction of its systematic error as a function of the alleged dating t.

The real catalogue contains random errors apart from the indicated systematic errors. Therefore, the discrepancies $B_i(t)$-b_i are random, and their values are scattered around the sine curve of their average value as seen in fig. 5.2. Assuming that other errors of the catalogue than the systematic ones are of a random nature, the problem of calculating $\gamma(t)$ and $\varphi(t)$ is one of regression parameter determination.

3. CALCULATING PARAMETERS $\gamma(t)$ AND $\varphi(t)$ WITH THE METHOD OF MINIMAL SQUARES

Let us find the solution for the minimization problem 5.2.4 and 5.2.5 expressed as $\gamma(t)$ and $\varphi(t)$. Below, in actual examples, this problem will be considered for groups containing different quantities of stars. We shall therefore be using the following standardized values for our calculations for which N will define the quantity of stars in the group under study.

$$\sigma_0^2(\gamma,\varphi,t)=\frac{1}{N}\sigma^2(\gamma,\varphi,t),$$

$$s_b(t)=\frac{1}{N}\sum_{i=1}^{N}\Delta B_i(t)\sin L_i(t),$$

$$c_b(t)=\frac{1}{N}\sum_{i=1}^{N}\Delta B_i(t)\cos L_i(t),$$

$$s_2(t)=\frac{1}{N}\sum_{i=1}^{N}\sin^2 L_i(t),$$

$$c_2(t)=\frac{1}{N}\sum_{i=1}^{N}\cos^2 L_i(t),$$

$$d(t)=\frac{1}{N}\sum_{i=1}^{N}\sin L_i(t)\cos L_i(t).$$

Let us point out that all such values can be calculated for any time moment t, depending on the values of the modern stellar coordinates as well as the star coordinates in the Almagest catalogue.

Obviously, the minimization problem 5.2.4 is equivalent to the minimization problem

$$\sigma_0^2(\gamma,\varphi,t)\rightarrow\min, \qquad (5.3.1)$$

in the sense that the parameters $\gamma(t)$ and $\varphi(t)$ defined by the relation 5.3.1 coincide with the parameters defined by the solution of the problem 5.2.4.

As we already pointed out, solving problem 5.3.1 only makes sense for large stellar groups, and since we shall study the statistical properties of such a solution below, we shall hereafter use $\gamma_{stat}(t)$ and $\varphi_{stat}(t)$ in order to refer to values which satisfy to relation 5.3.1.

The value of

$$\sigma_{min}(t)=\sigma_0(\gamma_{stat}(t),\varphi_{stat}(t),t) \qquad (5.3.2)$$

is rather transparent from the point of view of physics. It is the square average latitudinal discrepancy as applied to the group of stars under study for moment t resulting from the compensation of the discovered systematic error in $\gamma_{stat}(t)$ and $\varphi_{stat}(t)$. As we shall see below, the value of $\sigma_{min}(t)$ is hardly dependent on time at all due to the extremely low proper movement velocity of most stars. Thus, we shall also use the indication σ_{min}. Bear in mind that the square average latitudinal discrepancy prior to the compensation of this error would equal the following value for moment t:

$$\sigma_{init}=\sigma_0(0,0,t)=\sqrt{\frac{1}{N}\sum_{i=1}^{N}(\Delta B_i(t))^2}, \qquad (5.3.3)$$

Thus, the difference $\Delta\sigma(t)=\sigma_{init}(t)-\sigma_{min}(t)$ estimates the effect of compensating the systematic error $\gamma_{stat}(t)$, $\varphi_{stat}(t)$.

Further on when we shall define the values of $\gamma_{stat}(t)$ and $\varphi_{stat}(t)$ from the relation 5.3.1, we shall presume the time moment t to be fixed. We shall therefore omit argument t from our calculations, that is, we shall use L_i instead of $L_i(t)$, s_b instead of $s_b(t)$ etc.

In order to find the minimum in the relation 5.3.1, we shall take the partial derivatives of functions $\sigma_0^2(\gamma,$

$\varphi, t)$ by γ and φ and render them to zero. Bearing the formula $\sin(L_i + \varphi) = \sin L_i \cos\varphi + \cos L_i \sin\varphi$ in mind, we shall end up with the following equations:

$$s_b \cos\varphi + c_b \sin\varphi = \\ = \gamma \left[s_2 \cos^2\varphi + 2d \cos\varphi \sin\varphi + c_2 \sin^2\varphi\right], \quad (5.3.4)$$

$$-c_b \cos\varphi + s_b \sin\varphi = \\ = \gamma \left[-d \cos^2\varphi + (s_2 - c_2) \cos\varphi \sin\varphi + d \sin^2\varphi\right]. \quad (5.3.5)$$

If we divide the equation 5.3.4 by 5.3.5, we shall get

$$\frac{s_b + c_b \tan\varphi}{-c_b + s_b \tan\varphi} = \frac{s_2 + 2d \tan\varphi + c_2 \tan^2\varphi}{-d + (s_2 - c_2)\tan\varphi + d \tan^2\varphi}.$$

Once we render both parts of this equation to a common denominator, we shall come to the following equation concerning $\tan\varphi$:

$$(1+\tan^2\varphi)(c_b s_2 - s_b d) + (1+\tan^2\varphi)\tan\varphi(c_b d - s_b c_2) = 0.$$

This makes it easy to calculate the tangent of the optimal value of φ_{stat}:

$$\tan\varphi_{stat} = \frac{s_b d - c_b s_2}{c_b d - s_b c_2}. \quad (5.3.6)$$

The equation 5.3.6 permits a unique determination of φ_{stat}; after that, the optimal value of γ_{stat} can be deducted from 5.3.4, for instance:

$$\gamma_{stat} = \\ = \frac{s_b \cos\varphi_{stat} + c_b \sin\varphi_{stat}}{s_2 \cos^2\varphi_{stat} + 2d \cos\varphi_{stat} \sin\varphi_{stat} + c_2 \sin^2\varphi_{stat}} = \\ = \frac{\sqrt{c_b d^2 - 2 s_b c_b d + s_b^2 c_2^2 + c_b^2 s_2^2}}{d^2 - s_2 c_2} \quad (5.3.7)$$

Formulae 5.3.6 and 5.3.7 make it feasible to find the desired solution of the problem of calculating the estimations for φ_{stat} and γ_{stat} by the method of minimal squares.

It would be expedient to conduct a sensitivity analysis for this problem. Let us regard the second-order partial derivatives of the function $\sigma^2(\gamma, \varphi, t)$ with respect to γ and φ:

$$a_{11}(t) = \left.\frac{\partial^2\sigma^2(\gamma,\varphi,t)}{\partial\gamma^2}\right|_{\gamma=\gamma_{stat}(t),\varphi=\varphi_{stat}(t)}$$

$$a_{12}(t) = \left.\frac{\partial^2\sigma^2(\gamma,\varphi,t)}{\partial\gamma\partial\varphi}\right|_{\gamma=\gamma_{stat}(t),\varphi=\varphi_{stat}(t)}$$

$$a_{22}(t) = \left.\frac{\partial^2\sigma^2(\gamma,\varphi,t)}{\partial\varphi^2}\right|_{\gamma=\gamma_{stat}(t),\varphi=\varphi_{stat}(t)}$$

Keeping in mind the equations 5.3.4-5.3.7, we can easily determine the following expressions for these partial derivatives:

$$a_{11} = 2(s_2 \cos^2\varphi_{stat} + 2d \cos\varphi_{stat} \sin\varphi_{stat} + c_2 \sin^2\varphi_{stat}) = \\ = (2/\gamma_{stat})(s_b \cos\varphi_{stat} + c_b \sin\varphi_{stat}), \\ a_{12} = 2(c_b \cos\varphi_{stat} - s_b \sin\varphi_{stat}), \\ a_{22} = 2\gamma_{stat}^2 (s_2 \sin^2\varphi_{stat} - 2d \sin\varphi_{stat} \cos\varphi_{stat} + c_2 \cos^2\varphi_{stat}) \quad (5.3.8)$$

In order to estimate the errors in calculating the square average error rate $\sigma(\gamma, \varphi, t)$ considering the aberration of the values γ and φ from the calculated optimal values φ_{stat} and γ_{stat}, let us use the following decomposition of the function $\sigma^2(\gamma, \varphi, t)$ for the vicinity of point $(\gamma(t), \varphi(t))$:

$$\sigma^2(\gamma,\varphi,t) \approx \sigma^2_{\min} + a_{11}(t)(\gamma - \gamma_{stat}(t))^2 + \\ +2a_{12}(t)(\gamma - \gamma_{stat}(t))(\varphi - \varphi_{stat}(t)) + a_{22}(t)(\varphi - \varphi_{stat}(t))^2. \quad (5.3.9)$$

In the last formula we disregard the terms of magnitude order three and higher as related to the differences $\gamma - \gamma_{stat}(t)$ and $\varphi - \varphi_{stat}(t)$.

Formula (5.3.9) allows for an elementary estimation of the sensitivity of the square average error $\sigma(\gamma, \varphi, t)$ to the variation of parameters γ and φ. For this purpose it suffices to determine the values a_{11}, a_{12} and a_{22} pertinent to the right part of 5.3.9. After the estimation of $\gamma_{stat}(t)$ and $\varphi_{stat}(t)$, they can be easily calculated by the formula 5.3.8.

Formula 5.3.9 demonstrates that the "level curves" of square average errors manifest as ellipses on the plane (γ, φ), qv in fig. 5.3. The centre of the ellipsis is in point $(\gamma_{stat}, \varphi_{stat})$ for which the value of the square average error equals σ_{min}. The direction of the elliptic

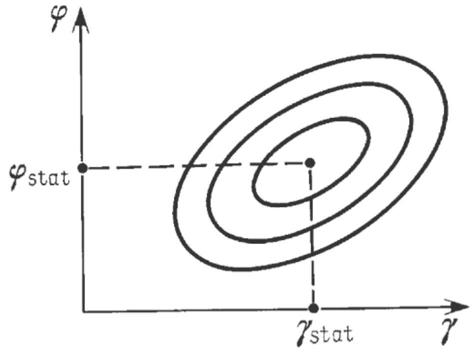


Fig. 5.3. Level curves of square average error σ (γ, φ, t) where t is a fixed value.

axes and the relation between them are determined by the standard analytical geometry formulae through the values a_{11}, a_{12} and a_{22}, namely, the tilt angle α of one of the ellipse axes is determined by the following relation:

$$\tan 2\alpha = \frac{2a_{12}}{a_{11} + a_{22}}.$$

The second axis is perpendicular to the first. The lengths of the axes relate to each other as λ_1/λ_2, where λ_1 and λ_2 are the roots of the quadratic equation

$$\lambda^2 - \lambda(a_{11} + a_{22}) + (a_{11}\, a_{22} - a_{12}^2) = 0.$$

4. VARIATION OF THE PARAMETERS $\gamma_{stat}(t)$ AND $\varphi_{stat}(t)$ OVER THE COURSE OF TIME

Above we have made the assumption that the moment t is fixed. We shall now consider how the passage of time affects the behaviour of the calculated values γ_{stat} and φ_{stat}.

This behaviour can be determined from the formulae cited in the previous section. These formulae contain the values $L_i(t)$ and $B_i(t)$ which define the temporal dependency of γ_{stat} and φ_{stat}. The changes of the longitudes ($L_i(t)$) and the latitudes ($B_i(t)$) over the course of time have been studied well enough, qv in Chapter 1. The respective calculations were of a complex enough nature and required the use of a computer for a quantitative calculation of temporal dependency estimation for $\gamma_{stat}(t)$ and $\varphi_{stat}(t)$, qv in Chapter 6. We shall merely analyse the qualitative behaviour of these functions herein.

Let us once again consider the celestial sphere, assuming all of the stars thereupon to be immobile for the sake of simplicity, thus returning to Ptolemy's conceptions, albeit merely for the sake of simplifying the argumentation and the calculations. We are well entitled to it since the percentage of the stars with noticeable proper movement velocity (ones that move by several arc minutes over the 2500-year time interval under study) is comparatively low. Such stars hardly affect the calculation of parameters $\gamma_{stat}(t)$ and $\varphi_{stat}(t)$ that we are concerned with presently.

In fig.5.4 one sees the celestial sphere as well as the real ecliptic for catalogue compilation epoch t_A. It would be expedient to compare figs. 5.1 and 5.4. In the epoch t_A that remains unknown to us the ecliptic pole $P(t_A)$ was occupying a certain position on the celestial sphere. The compiler of the catalogue was naturally not ideally precise in his indication of the ecliptic on the celestial sphere. Therefore the pole P_A of his "catalogue ecliptic" assumed a position differing from that of $P(t_A)$.

Let us draw the arc of a large circle that shall connect the pole $P(t_A)$ with the respective vernal and autumnal equinox points Q and R. In addition, we shall

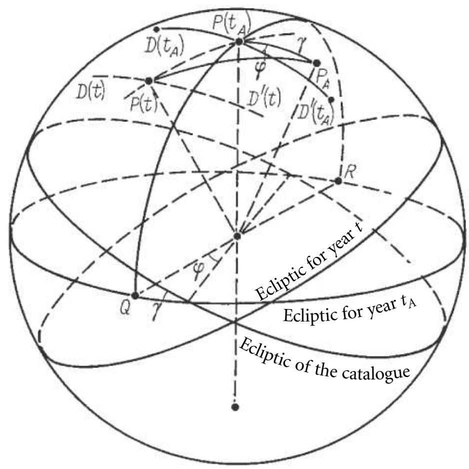


Fig. 5.4. Geometrical definition of the angles φ and γ on the celestial sphere.

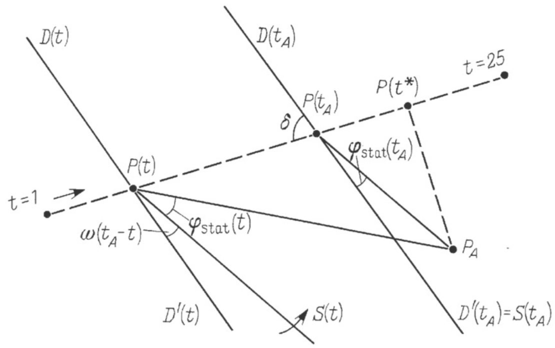


Fig. 5.5. Calculating the qualitative temporal dependency of $\gamma_{stat}(t)$ and $\varphi_{stat}(t_A)$.

draw the arc of the large circle $D(t_A)D'(t_A)$ that shall pass through $P(t_A)$ and cross the recently-built arc $Q\ P(t_A)R$ at a right angle in point $P(t_A)$. If we knew the date t_A, then the method of minimal squares as described in section 3, would give us the opportunity to find the parameters of γ and φ that define the mutual disposition of the ecliptic for epoch t_A and the catalogue ecliptic. Fig. 5.4 demonstrates that these very angles also define the mutual disposition of the poles $P(t_A)$ and P_A on the celestial sphere – namely, the value of γ equals the length of the arc $P(t_A)P_A$ in arc values, and angle φ equals the angle $P_AP(t_A)D'(t_A)$. As we point out in Chapter 1, the celestial position of the ecliptic alters in the course of time. This is the manifestation of the ecliptic fluctuation effect. Therefore, the ecliptic pole for moment t that differs from t_A shall be located in point $P(t)$ which will also differ from $P(t_A)$.

The ecliptic pole trajectory on the celestial sphere is indicated with a dotted line in fig. 5.4, one that crosses the points $P(t)$ and $P(t_A)$. Thus, in order to combine the ecliptic of epoch t with the catalogue ecliptic, one has to superpose poles P_A and $P(t)$ over one another. The length of arc $P(t)P_A$ equals the value of $\gamma_{stat}(t)$, and the location of the ecliptic rotation axis that provides for such a superposition can be parameterised by angle $P_AP(t)D'(t)$ where arc $D(t)D'(t)$ is "parallel" to arc $D(t_A)D'(t_A)$.

In order to understand the quantitative behaviour of the functions $\gamma_{stat}(t)$ and $\varphi_{stat}(t)$ better, let us use a two-dimensional drawing depicting just the ecliptic pole shifts. This is permissible, since the values of their shifts are a priori known to fall into the range of one degree. We shall thus make a two-dimensional copy of the polar part of fig. 5.4 – see fig. 5.5.

As it is obvious from fig. 5.5, the real ecliptic pole shifts over the course of time due to the fluctuation of the ecliptic. For the interval under study the value of this shift equals a mere 25' on the average, and so we can draw it as a straight line (see the dotted line in fig. 5.5). The motion of the ecliptic pole along this line can be considered uniform with a high enough degree of precision. And so, the distance between the poles $P(t)$ and $P(t_A)$, for example, shall equal $v(t_A - t)$ where v is the velocity of the ecliptic pole's motion. This velocity approximates 0.01' per year. As we have mentioned above, in the observation epoch t_A the catalogue compiler had made a mistake in his estimate of the ecliptic plane which resulted in the shift of the catalogue ecliptic pole into point P_A which differs from $P(t_A)$. Should this result in the perpendicular between P_A and the ecliptic pole motion trajectory cross it in point $t^* > t_A$ as is the case in fig. 5.5, this error of the compiler shall obviously add extra age to the catalogue ecliptic, namely, make it correspond best to the ecliptic of the year t^*. The opposite happens if this perpendicular crosses the trajectory in point $t^* < t_A$ – the author's mistake would thus make the catalogue "more recent". In order to give the reader an impression of the real value correlations, we shall indicate that for the Almagest the distance between ecliptic poles $P(0)$ for 1900 A.D. and $P(19)$ for the early A.D. period roughly equals 20' – the value approximates that of the error $\gamma_{stat}(t_A)$.

Earlier we mentioned that the value $\gamma_{stat}(t_A)$ equalled the length of segment $P(t_A)P_A$, whereas $\varphi_{stat}(t_A)$ was equal to angle $P_AP(t_A)D'(t_A)$. In a similar manner, $\gamma_{stat}(t) = \overline{P(t)P_A}$. Here the horizontal line on top refers to the length of the segment. However, angle $P_AP(t)D'(t)$ does not equal $\varphi_{stat}(t)$, since by moment t the vernal equinox axis would shift by the value $\omega(t_A - t)$.

Here ω stands for the annual angle velocity of precession that roughly equals 50", qv in Chapter 1. This shift corresponds to the value of angle $D'(t)P(t)S(t)$ in fig. 5.5. Thus, $\varphi_{stat}(t)$ is equal to the angle $P_AP(t)S(t)$, where angle $D'(t)P(t)S(t) = \omega(t_A - t)$.

In order to evade such bulky indications, let us assume that

$$x(t) = \overline{P(t)P(t_A)},\qquad y = \overline{P(t_A)P(t^*)},\qquad z = \overline{P_A P(t^*)},$$
$$\psi(t) = \angle P_A P(t) D'(t),\qquad \delta = \angle D(t_A) P(t_A) P(t).$$

The value of $\gamma_{stat}(t_A)$ can be referred to as the ecliptic estimation error; it has the order of 20' in the Almagest. Angle δ does not depend on t and equals the angle between the motion direction of the ecliptic pole and line $D(t_A)D'(t_A)$ as estimated above. It is obvious that

$$z = \gamma_{stat}(t_A)\sin(\delta - \varphi_{stat}(t_A)),$$
$$y = \gamma_{stat}(t_A)\cos(\delta - \varphi_{stat}(t_A)).$$

Since $x(t) = v(t_A - t)$, from fig. 5.5 we get

$$\gamma_{stat}(t) = \sqrt{(v(t_A - t) + y)^2 + z^2} =$$
$$= \sqrt{\gamma_{stat}^2(t_A) + 2yv(t_A - t) + v^2(t_A - t)^2}. \tag{5.4.1}$$

Quite obviously, the minimal value of this function is reached with $t = t^*$. If we are studying a case of $|t - t_A| << |t_A - t^*|$, the function of $\gamma_{stat}(t)$ behaves almost as if it were linear:

$$\gamma_{stat}(t) \approx \gamma_{stat}(t_A) + v\cos(\delta - \varphi_{stat}(t_A))(t_A - t).$$

The function of $\varphi_{stat}(t)$ is also easy enough to find:

$$\varphi_{stat}(t) = \delta + \omega(t_A - t) - \arctan\left(\frac{z}{y + v(t_A - t)}\right). \tag{5.4.2}$$

Once again, if $|t - t_A| << |t_A - t^*|$, one can use linear approximation:

$$\varphi_{stat}(t) = \varphi_{stat}(t_A) + \left[\omega + \frac{v\sin(\delta - \varphi_{stat}(t_A))}{\gamma_{stat}(t_A)}\right](t_A - t).$$

Naturally, the formulae that we end up with can only give us a general idea of the character of such functions as $\gamma_{stat}(t)$ and $\varphi_{stat}(t)$. In fig. 5.6 we can see an approximated representation of these functions that we get from the formulae 5.4.1 and 5.4.2. It is obvious that their actual form depends on the error rate for the catalogue compiler's accuracy, that is, the values of $\gamma_{stat}(t_A)$ and $\varphi_{stat}(t_A)$. Formulae 5.4.1 and 5.4.2 also define the nature of the dependency $\beta_{stat}(t)$, qv in formula 5.2.1.

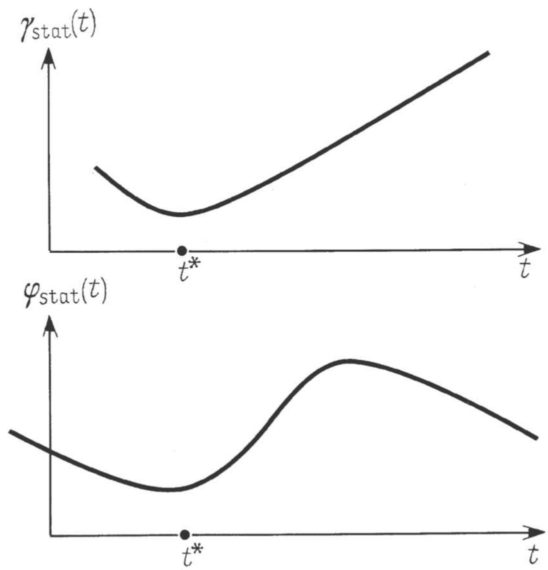


Fig. 5.6. Approximate view of the functions $\gamma_{stat}(t)$ and $\varphi_{stat}(t)$.

Let us discuss the geometrical meaning of these calculations. We shall consider the Ptolemian coordinates of a certain star groups considering the observations to have been carried out in the time moment t. We must then compensate the systematic error $\gamma_{stat}(t)$, $\varphi_{stat}(t)$, or rotate the entire group by angle $\gamma_{stat}(t)$ around the axis which is on the distance $\varphi_{stat}(t)$ from the equinox axis. We shall assume that we have been perfectly precise in our estimation of the systematic error. Then the catalogue ecliptic pole P_A shall become superimposed over the real pole $P(t)$. Obviously, such a superimposition will not make the latitudinal discrepancies of the stars equal zero, since the catalogue also contains random errors. However, these errors do not affect the position of the ecliptic pole, having a null average value – or, rather, they affect it to a very small extent which is inversely proportional to the quantity of the star group under study.

From fig. 5.5 we see that the shift of pole P_A towards the point $P(t)$ can be decomposed into a composition of two shifts – P_A to $P(t_A)$ and $P(t_A)$ to $P(t)$

in a single possible manner. The parameters $\gamma_{stat}(t_A)$ and $\varphi_{stat}(t_A)$ which define the first shift refer to the observer's error, namely, the error made by the catalogue compiler in the estimation of the ecliptic plane. The second shift is defined by the centenarian fluctuation of the ecliptic plane which can be calculated by Newcombe's theory.

All of the above also implies the following corollary. Let us mark the latitudinal discrepancy of star i calculated for the presumed observation moment t as $\Delta B_i(t)$, and the same discrepancy for moment t after the compensation of the systematic error as $\Delta B_i^0(t) = \Delta B_i(t) - \gamma_{stat}(t)\sin(L_i(t) + \varphi_{stat}(t))$. Then the values of $\Delta B_i^0(t)$ shall be independent from t and equal the random errors made by Ptolemy in the estimation of the latitudes. The situation changes when mobile stars enter the stellar group under study. For them the value of $\Delta B_i^0(t)$ shall depend on the time t. The dependency character is defined by the values of individual random errors as well as the direction of proper motion velocities of all stars as viewed at once. In particular, for the unknown epoch t_A the value of $\Delta B_i^0(t_A)$ shall equal the random latitudinal error for star i. It would be natural to expect that if this star moves fast enough, and happens to be well-measured at the same time, the value of $\Delta B_i^0(t)$ should reach its minimum somewhere around the point t_A. The size of this minimum range depends on the value and the velocity of a given star's proper motion and equals hundreds of years even for the fastest of stars – Arcturus, for instance.

The above consideration and fig. 5.5 have a rather important implication that in order to determine the pole P_A of the catalogue ecliptic we only need to know the two values of γ_{stat} which will correspond to two respective time moment values – t_1 and t_2.

Indeed, Newcomb's theory makes it relatively easy to determine the ecliptic pole motion speed v, qv in Chapter 1. Let us fix two arbitrarily chosen time moments t_1 and t_2 (see fig. 5.7). We shall use the formula 5.3.7 to calculate the values of $\gamma_{stat}(t_1)$ and $\gamma_{stat}(t_2)$. Let us now draw the line of the ecliptic pole's motion through time, marking the points t_1 and t_2 thereupon. The scale we have to choose must make the distance between the two points equal $v|t_2 - t_1|$. The position of the ecliptic pole P_A is determined as the intersection point of the two circumferences whose centres are

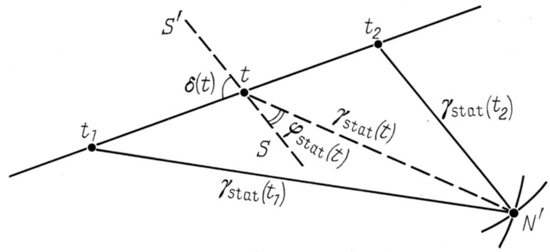


Fig. 5.7. Calculating the values of $\gamma_{stat}(t)$ and $\varphi_{stat}(t)$.

located in points t_i and whose radiuses equal $\gamma_{stat}(t_i)$, $i = 1.2$. Fig. 5.7 demonstrates how one calculates the values of $\gamma_{stat}(t)$ and $\varphi_{stat}(t)$ that correspond to arbitrary t values. It just has to be noted that the line $S'S$ that angle $\varphi_{stat}(t)$ is counted from crosses the trajectory of the ecliptic pole motion at angle $\delta(t)$. This angle can also be calculated with the aid of Newcomb's theory. The astronomical meaning of the straight line $S'S$ is obvious enough – it is a "straightened out" part of a large circumference pertaining to the celestial sphere that crosses the ecliptic pole $P(t)$ of epoch t and is perpendicular (at $P(t)$) to another large circumference which also crosses $P(t)$ and the equinox point of epoch t.

In a similar way, the calculation of the parameters $\gamma_{stat}(t)$ and $\varphi_{stat}(t)$ for all the values of t shall require the knowledge of two values only – $\varphi_{stat}(t_1)$ and $\varphi_{stat}(t_2)$.

We shall however work with angle γ. It is a pithy value, being the error in the estimation of the tilt angle between the equatorial and the ecliptic plane. Let us point out that this angle can be fixed with the use of the armillary sphere, for instance. Therefore, the error γ inherent in the value of this angle may be an instrumental error of the armillary sphere, qv in Chapter 1. Thus, error γ arises in the course of astronomical observation naturally. Apart from that, the choice of γ for the representation of a parameter shall further receive statistical validation.

5. THE STATISTICAL PROPERTIES OF THE ESTIMATES OF γ_{stat} AND φ_{stat}

We shall now consider the problem of calculating the parameters γ and φ which define the systematic error of the catalogue as a problem of statistics. Let

us assume the following for this purpose: the catalogue compiler introduced the systematic error at time moment t_A; said error is defined by parameters γ_A and φ_A. Apart from that, let us assume the latitude of each measured star to have been affected by the random perturbation ξ_i with a zero average as a result of the observation error, or $E\xi_i = 0$. It is presumed that random errors ξ_i which correspond to different stars are independent and distributed uniformly. Let $\sigma^2 = E\xi_i^2$ stand for the dispersion of the random value ξ_i; this dispersion remains unknown to us in general.

The latitude of star i shall assume the following form in these presumptions:

$$b_i = B_i(t_A) - \gamma_A \sin(L_i(t_A) + \varphi_A) + \xi_i \qquad (5.5.1)$$

From the statistical point of view, what we have in front of us is a sample that consists of N realizations of random values $\{b_i\}_{i=1}^N$ of the 5.5.1 variety. This sample has to be used for the statistical calculation of $\hat{\gamma}$ and $\hat{\varphi}$ parameters of γ_A and φ_A, as well as the calculation of the σ value which is equal to the square average equation error. We shall localize the problem immediately and study the estimations of $\hat{\varphi} = \varphi_{stat}$ and $\hat{\gamma} = \gamma_{stat}$ calculated with the minimal square method. These estimations have the form of 5.3.6 and 5.3.7. Most of our attention shall be turned towards the estimation of the γ_A value for reasons explained at the end of Section 4.

Formula 5.5.1 looks traditional for regression analysis. Indeed, this equation claims observation error $\Delta b_i = B_i(t_A) - b_i$ to be a random value with the average $\gamma_A \sin(L_i(t_A) + \varphi_A)$ depending on unknown parameters γ_A and φ_A, and the dispersion σ^2. One has to estimate the values of unknown parameters using the minimal square method and determine the statistical qualities of the estimations received. Under such conditions, the curve $Y(x) = \gamma_A \sin(x + \varphi_A)$ is usually referred to as the line of regression.

Let us define the values of γ and φ using the relations expressed in 5.3.6 and 5.3.7. Discrepancies Δb_i are random by presumption. Therefore, the estimates of φ_{stat} and γ_{stat} that we get from these formulae are random values as well. Let us study their statistical qualities and consider their relation to the unknown true values of φ_A and γ_A.

Let us perform a substitution for s_b and c_b in the formulae related above, using the difference $\gamma_A \sin(L_i(t_A) + \varphi_A) - \xi_i$ instead of Δb_i and apply said substitution to formulae 5.3.6 and 5.3.7. We shall come up with the following expressions for the values φ_{stat} and γ_{stat}.

$$\tan\varphi_{stat} = \frac{\tan\varphi_A + \dfrac{\frac{1}{N}\sum_{i=1}^N \xi_i (s_2 \cos L_i(t_A) - d \sin L_i(t_A))}{\gamma_A (d^2 - s_2 c_2)\cos\varphi_A}}{1 + \dfrac{\frac{1}{N}\sum_{i=1}^N \xi_i (c_2 \sin L_i(t_A) - d \cos L_i(t_A))}{\gamma_A (d^2 - s_2 c_2)\cos\varphi_A}} \qquad (5.5.2)$$

$$\gamma_{stat} = \gamma_A - \frac{\frac{1}{N}\sum_{i=1}^N \xi_i (\sin L_i(t_A) + \tan\varphi_A \cos L_i(t_A))}{(s_2 + 2d\tan\varphi_A + c_2 \tan^2\varphi_A)\cos\varphi_A}. \qquad (5.5.3)$$

Let us introduce the value

$$R = (\gamma_A (d^2 - s_2 c_2) \cos\varphi_A)^{-1}.$$

In this case 5.5.2 can be transcribed as

$$\tan\varphi_{stat} = \frac{\tan\varphi_A + \frac{R}{N}\sum_{i=1}^N \xi_i (s_2 \cos L_i(t_A) - d \sin L_i(t_A))}{1 + \frac{R}{N}\sum_{i=1}^N \xi_i (c_2 \sin L_i(t_A) - d \cos L_i(t_A))}. \qquad (5.5.4)$$

The condition $E\xi_i = 0$ tells us that the received estimation of parameter γ_{stat} is not shifted, that is:

$$E\gamma_{stat} = \gamma_A. \qquad (5.5.5)$$

The dispersion for the estimation of γ_{stat} expressed through D_γ looks like this:

$$D_\gamma = \frac{\sigma^2}{N(\cos^2\varphi_A s_2 + 2d\cos\varphi_A \sin\varphi_A + c_2 \sin^2\varphi_A)}. \qquad (5.5.6)$$

If observation errors ξ_i are distributed normally, the same applies to the value γ_{stat}, and the first two moments (5.5.5 and 5.5.6) define its entire distribution. This fact shall give us an opportunity to build the trust interval for the value of γ_A.

The estimation analysis of φ_{stat} is a bit more complex. Let us used the equation rendered from formula 5.5.4:

$$\tan\varphi_{stat} - \tan\varphi_A =$$

$$= \frac{\frac{R}{N}\sum_{i=1}^{N}\xi_i((s_2 + d\tan\varphi_A)\cos L_i(t_A) - (d + c_2\tan\varphi_A)\sin L_i(t_A))}{1 + \frac{R}{N}\sum_{i=1}^{N}\xi_i(c_2\sin L_i(t_A) - d\cos L_i(t_A))} \quad (5.5.7)$$

as well as the fact that for large values of N the second item in the denominator of the right part of 5.5.7 is a small value. This value is indeed of a random nature, with a null average and the dispersion of

$$\frac{\sigma^2 c_2}{N\gamma_A^2(s_2c_2 - d^2)\cos^2\varphi_A}.$$

If ξ_i are distributed normally, the same applies to the value under study. It has the following implication for the Almagest: even for $N = 30$ the probability P_N that the denominator of the right part of 5.5.7 shall be negative does not exceed 5×10^{-3}. This probability diminishes drastically with the growth of N: $P_{50} \leq 2.5 \times 10^{-4}$, $P_{80} \leq 4 \times 10^{-6}$, $P_{100} \leq 3 \times 10^{-7}$, $P_{200} \leq 8 \times 10^{-13}$, $P_{300} \leq 2.5 \times 10^{-8}$.

Formula 5.5.7 implies that, in general, $E\tan\varphi_{stat} \neq \tan\varphi_A$. However, we can easily obtain distribution function $F(x)$ of the random value $\tan\varphi_{stat} - \tan\varphi_A$ from this formula which we need for the estimation of the trust interval for φ_A. Indeed, if we are to disregard the rather improbable case of the denominator in 5.5.7 becoming negative, we can educe the expression for $F(x)$ from this formula:

$$F(x) = P(\tan\varphi_{stat} - \tan\varphi_A < x) = P(\eta_x - x),$$

where random value η_x has the form of

$$\eta_x = \frac{R}{N}\sum_i \xi_i((s_2 + d(\tan\varphi_A + x)\cos L_i(t_A)) - (d + c_2(\tan\varphi_A + x)\sin L_i(t_A))).$$

Therefore, if values ξ_i are distributed normally with the dispersion equalling σ^2, value η_x shall have Gaussian distribution with a null average and the dispersion of

$$D(\eta_x) = \frac{R^2\sigma^2}{N}(c_2s_2 - d^2)(s_2 + 2d(x + \tan\varphi_A) + c_2(x + \tan\varphi_A)^2). \quad (5.5.8)$$

Thus,

$$F(x) = \Phi(x/\sqrt{D(\eta_x)}), \quad (5.5.9)$$

where $\Phi(x) = (2\pi)^{-1/2}\int_{-\infty}^{x}\exp(-u^2/2)du.$

The values of γ_{stat} and φ_{stat} as calculated above are the so-called punctual estimations of the unknown parameters γ_A and φ_A. Since we have found the distribution functions for these estimations, one can study the issue of possible errors inherent therein. Let us answer this question in standard terms used for trust intervals based on formulae 5.5.5, 5.5.6, 5.5.8 and 5.5.9.

In mathematical statistics the problem of confidence interval calculation is dependent on the following situation that we shall illustrate with the example of estimating the value of γ_A. This value is a deterministic error of a very certain nature made by the compiler of the catalogue. As a result of the statistical estimation of γ_A – with the aid of the minimal square method in our case – we end up with the random value γ_{stat}. One wonders about the boundaries of the unknown value γ_A if we already managed to determine γ_{stat}.

In order to keep these boundaries from becoming trivial, we have to define the acceptable error rate probability – that is, the probability of specifying such boundaries that shall not contain the true value of γ_A. Let us use ε for referring to the acceptable error rate probability. Confidence level shall equal $1 - \varepsilon$ in such a case. The random value of γ_{stat} is distributed normally, with parameters defined by formulae 5.5.5 and 5.5.6. Therefore, for $x > 0$ we shall have

$$P(|\gamma_{stat} - \gamma_A| < x) = \Phi(\sqrt{D_\gamma}x) - \Phi(-\sqrt{D_\gamma}x).$$

Let us define the value of $(\varepsilon/2)$ – the fractiles of normal x_ε distribution from the equation:

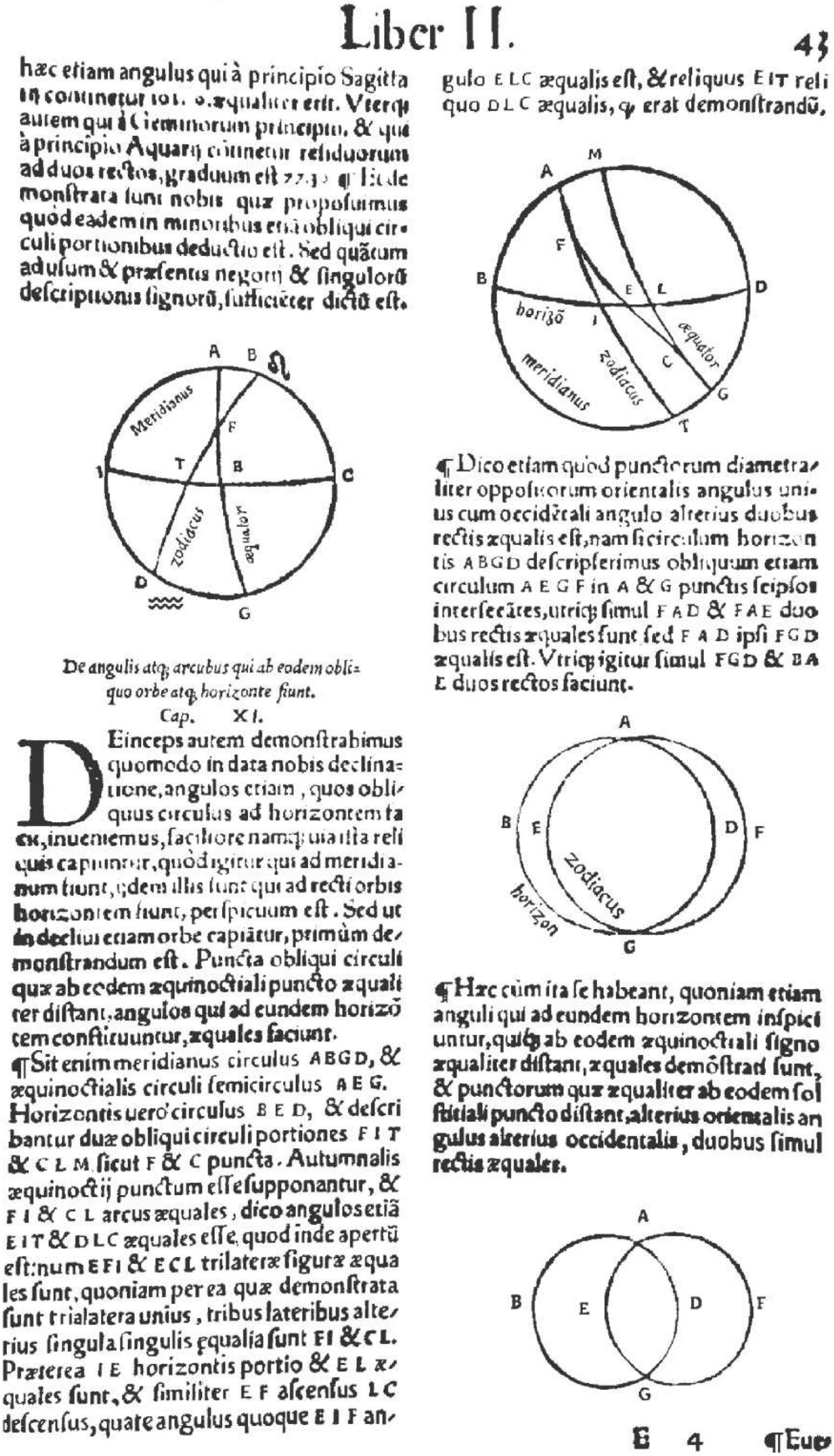
$$\Phi(\sqrt{D_\gamma}x_\varepsilon) - \Phi(-\sqrt{D_\gamma}x_\varepsilon) = 1 - \varepsilon,$$

or, alternatively, another equation that gives the same result $\Phi(-\sqrt{D_\gamma}x_\varepsilon) = \varepsilon/2$.

Then the interval

$$I_\gamma(\varepsilon) = (\gamma_{stat} - x_\varepsilon, \gamma_{stat} + x_\varepsilon) \quad (5.5.10)$$

shall represent the confidence interval for γ_A with confidence level of $1 - \varepsilon$. This follows from $P(|\gamma_{stat} - \gamma_A| \geq x_\varepsilon) = \varepsilon$.



Liber II. 43

hæc etiam angulus qui à principio Sagitta
rij continetur 101. o. æqualiter erit. Vterq;
autem qui à Geminorum principio, & qui
à principio Aquarij cótinetur reſiduorum
ad duos rectos, graduum eſt 77. 30. ¶ Hæc de
monſtrata ſunt nobis quæ propoſuimus
quòd eadem in minoribus etiã obliqui cir-
culi portionibus deductio eſt. Sed quãtum
ad uſum & præſentis negotij & ſingulorũ
deſcriptionis ſignorũ, ſufficiẽter dictũ eſt.

*De angulis atq; arcubus qui ab eodem obli-
quo orbe atq; horizonte fiunt.*
Cap. XI.

DEinceps autem demonſtrabimus
quomodo in data nobis declina-
tione, angulos etiam, quos obli-
quus circulus ad horizontem fa
cit, inueniemus, faciliore namq; uia iſta reli
quis capiuntur, quòd igitur qui ad meridia-
num fiunt, ijdem illis ſunt qui ad recti orbis
horizontem fiunt, perſpicuum eſt. Sed ut
in decliui etiam orbe capiãtur, primùm de-
monſtrandum eſt. Puncta obliqui circuli
quæ ab eodem æquinoctiali puncto æquali
ter diſtant, angulos qui ad eundem horizõ
tem conſtituuntur, æquales faciunt.
¶ Sit enim meridianus circulus ABGD, &
æquinoctialis circuli ſemicirculus AEG.
Horizontis uerò circulus BED, & deſcri
bantur duæ obliqui circuli portiones FIT
& CLM, ſicut F & C puncta. Autumnalis
æquinoctij punctum eſſe ſupponantur, &
FI & CL arcus æquales, dico angulos etiã
EIT & DLC æquales eſſe, quod inde apertũ
eſt: num EFI & ECL trilateræ figuræ æqua
les ſunt, quoniam per ea quæ demonſtrata
ſunt trialatera unius, tribus lateribus alte-
rius ſingula ſingulis ęqualia ſunt FI & CL.
Præterea IE horizontis portio & EL æ-
quales ſunt, & ſimiliter EF aſcenſus LC
deſcenſus, quare angulus quoque EIF an-
gulo ELC æqualis eſt, & reliquus EIT reli
quo DLC æqualis, q̃ erat demonſtrandũ.

¶ Dico etiam quòd punctorum diametra-
liter oppoſitorum orientalis angulus uni-
us cum occidẽtali angulo alterius duobus
rectis æqualis eſt, nam ſi circulum horizon
tis ABGD deſcripſerimus obliquum etiam
circulum AEGF in A & G punctis ſeipſos
interſecãtes, utrique ſimul FAD & FAE duo
bus rectis æquales ſunt ſed FAD ipſi FGD
æqualis eſt. Vtrique igitur ſimul FGD & BA
E duos rectos faciunt.

¶ Hæc cùm ita ſe habeant, quoniam etiam
anguli qui ad eundem horizontem inſpici
untur, quibus ab eodem æquinoctiali ſigno
æqualiter diſtant, æquales demõſtrati ſunt,
& punctorum quæ æqualiter ab eodem ſol
ſtitiali puncto diſtant, alterius orientalis an
gulus alterius occidentalis, duobus ſimul
rectis æquales.

E 4 ¶ Eue

Fig. 5.8. A page from a 1551 edition of the Almagest.

When we try to calculate the value of x_ε, we must particularly lean upon the value of D_γ, which depends on the unknown parameters σ^2 and φ_A. As it is usually done in mathematical statistics, we shall replace σ^2 in the formula for D_γ by the residual dispersion

$$\sigma_0^2(\gamma_{stat}, \varphi_{stat}, t_A) = \frac{1}{N}\sum_{i=1}^{N}(\Delta B_i(t_A) - \gamma_{stat}\sin(L_i(t_A) + \varphi_{stat}))^2,$$

defined by formula 5.5.3, and φ_A by φ_{stat}. Catalogue compilation moment t_A also remains unknown to us; thus, all the calculations as listed above have to be carried out for all the time moments t in order to estimate the systematic error $\gamma_{stat}(t)$, $\varphi_{stat}(t)$, assuming the catalogue to have been compiled in the random fixed epoch t.

In a similar way we can educe the confidence interval for φ_A with the confidence level of $1 - \varepsilon$. This interval $I_\varphi(\varepsilon)$ shall look like this:

$$\left(\varphi_{stat} - \frac{y_\varepsilon}{1+\tan^2\varphi_{stat} - y_\varepsilon\tan\varphi_{stat}},\ \ \varphi_{stat} + \frac{y_\varepsilon}{1+\tan^2\varphi_{stat} + y_\varepsilon\tan\varphi_{stat}}\right), \tag{5.5.11}$$

y_ε being the solution of the equation $F(y) - F(-y_\varepsilon) = 1 - \varepsilon$, where distribution function F is defined by the equality 5.5.9, that is, $\varepsilon/2$ – fractile of the corresponding normal distribution.

Note: the above estimations of the true error rates for γ and φ in the catalogue as the presumed dating functions are not only important for our being able to compensate them, but also for the indirect verification of just how correct the suggested approach happens to be. For instance, if we came up with such a value of γ_{stat} that would be several times greater than the catalogue precision rate, it would indicate at the existence of substantial effects that we did not take into account.

However, inasmuch as the dating itself is concerned, the actual value of γ_{stat} takes no part in the corresponding procedure. All we need to know is the length of the respective trust interval. Therefore, one could simplify the calculations to a great extent in the following manner. One would have to calculate γ_{stat} and φ_{stat} for any fixed moment in time t_0: 1900 A.D., for instance, which would render Newcomb's calculations unnecessary. Then instead of the curves $\gamma_{stat}(t)$ and $\varphi_{stat}(t)$ we shall have constant values corresponding to observation errors – however, the coordinate system shall pertain to the epoch of 1900 A.D. Then we would draw confidence intervals around these constant values whose length will not depend on t. We shall end up with the same interval of possible catalogue datings as we did in our estimation of errors γ and φ for the presumed dating epoch t if we carry out the statistical dating procedure described below. The only information we shall lose after this shall be the estimated real values of γ_{stat} and φ_{stat}.

6. COROLLARIES

Corollary 1. The group error of a stellar configuration results in said configuration shifting across the celestial sphere as a whole. This shift can be parameterized by two parameters, namely, γ and φ (or γ and β), if we are to consider latitudinal discrepancies exclusively.

Corollary 2. The latitudinal discrepancies inherent in the catalogue can be reduced as a result of compensating the group errors.

Corollary 3. If group errors coincide for a large part of the catalogue, this common error is called systematic and can be discovered by statistical methods.

Under the condition that the catalogue compilation epoch equals t, the values of parameters $\varphi(t)$ and $\gamma(t)$ can easily be assessed with the minimal square method. The corresponding estimations of $\gamma_{stat}(t)$ and $\varphi_{stat}(t)$ have the respective forms of 5.3.6 and 5.3.7.

Corollary 4. It suffices to know the values of $\gamma_{stat}(t_1)$ and $\gamma_{stat}(t_2)$ for two different moments in time for the reconstruction of functions $\gamma_{stat}(t)$ and $\varphi_{stat}(t)$.

Corollary 5. Confidence intervals $I_\varphi(\varepsilon)$ and $I_\gamma(\varepsilon)$ for the real values of parameters $\varphi(t)$ and $\gamma(t)$ were calculated under the assumption of random errors being distributed normally. See the respective formulae 5.5.11 and 5.5.10.

Let us conclude by reproducing a page from a 1551 edition of the Almagest in fig. 5.8.

CHAPTER 6

Statistical and precision-related properties of the Almagest catalogue

1. INTRODUCTORY REMARKS

In the preceding chapters we have estimated that one of the primary problems with the dating of the Almagest by proper star motions is the problem of real precision of the Almagest catalogue star latitudes for different celestial regions. Therefore, one needs to conduct a meticulous analysis of star coordinate errata in the catalogue in general and different parts of the latter. A preliminary and rather rough analysis has already been conducted (see Chapters 2 and 4).

The primary instrument of this chapter shall include the methods of systematic star coordinate errata calculation as described in Chapter 5. First of all, we shall demonstrate that seven regions of the Almagest star atlas as described above do actually differ from each other by the system error rate as well as random measurement errata. We shall find errors in ecliptic pole estimation for each of these areas, as well as the values of residual square average star coordinate errata. Moreover, we shall build confidence intervals of systematic error parameters γ_{stat} and φ_{stat} for each of the areas.

Next we shall analyse certain comparatively small celestial areas – constellations and environs of individual stars. The goal of this analysis is to make sure that the discovered values of γ_{stat} and φ_{stat} do in fact possess the nature of systematic errata in substantial parts of the Almagest catalogue, and are by no means a mere result of numerous group errors superimposed over each other and differing from one small group of stars to another.

As a result, we shall calculate the area of the celestial sphere that was measured well enough by Ptolemy. In fact, it turned out rather significant. Our dating of the Almagest shall be based on star coordinates from this very area – one where Ptolemy's calculations were the most precise.

2. SEVEN REGIONS OF THE CELESTIAL SPHERE

2.1. A characteristic of the seven areas that we have discovered in the Almagest atlas

In Chapter 2 we have described seven areas that the celestial sphere can be divided into; they are also very manifest in the Almagest catalogue, qv in fig. 6.1.

In this chapter, we analyse Ptolemy's coordinates of 864 stars in total. These 864 stars were what we rendered the 100 stars of the Almagest to after a filtration of the following sort. Firstly, the so-called *informata* stars were removed due to reasons considered in Chap-

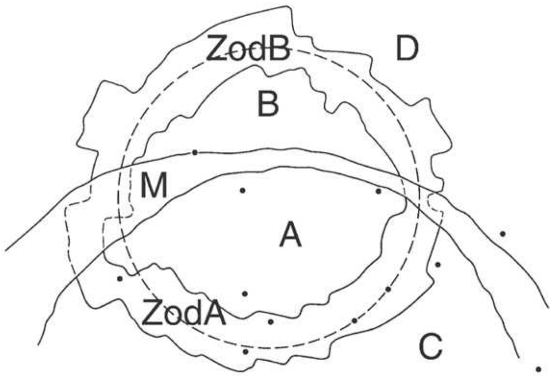


Fig. 6.1. Seven areas that we discovered in the star chart according to the Almagest. Named stars are represented by black dots.

ter 2 – they aren't included in the canonical constellations. Secondly, we have also filtered out the "rejects" and the ambiguously identified stars. Table 6.1 contains precise indications concerning the Almagest stars that a given region includes, and the residual amount of stars after the "filtration" for each area. We have used Bailey's numeration in this table, or star numbers from the Almagest catalogue.

Let us consider fig. 6.1, which represents the division of the celestial sphere into the abovementioned regions. All 12 named Almagest stars are marked as black dots. It is easy to see that the outline of area *A*

Region of the sky in the Almagest	*Bailey's numeration for the region before and after the filtration of the catalogue*	
	before	*after*
A	1-158 and 424-569	249
B	286-423 and 570-711	262
C	847-977	116
D	712-846 and 998-1028	143
M	159-285	94
Zod A	424-569	124
Zod B	362-423 and 570-711	168

Table 6.1. The distribution of the Almagest stars across the celestial areas with the specification of just how many stars remained in each of said areas after the filtration of the catalogue. We were using Bailey's enumeration, or the numbers of the stars as specified in the catalogue of the Almagest.

is very clearly defined by the named stars of the Almagest. One gets the impression that Ptolemy ascribed a special significance to celestial area *A*. This is also confirmed by our preliminary analysis in Chapter 2. As we shall see below, area A turns out the most important for our dating research. It also has to be pointed out that the area in question contains the celestial pole (marked *N*) and the ecliptic pole (marked *P*).

Named stars that surround area *A* must have served Ptolemy as a basis of some sort when he was performing his observations. He referred to them as he moved further towards the centre of area *A*, measuring the coordinates of all the other stars. Measurement errata accumulated as he moved from one star to another. One should therefore expect the stars from region *A* that lay outside the Zodiac to be measured worse in general than zodiacal stars. Half of the Almagest's named stars (6 out of 12) are either part of the Zodiac, or located in its immediate vicinity. The Zodiac includes Regulus, Spica, Antares, Previndemiatrix and Aselli. Procyon is right next to the Zodiac.

2.2. The disposition of the ecliptic poles for each of the seven regions of the Almagest star atlas

Let us first locate the disposition of the ecliptic poles for each of the seven celestial regions of the Almagest. In Chapter 5 we demonstrate that the position of the ecliptic pole in relation to the catalogue stars is set by parameters γ_{stat} and φ_{stat}. These parameters are estimated from the catalogue by the application of the minimal square method in accordance with the formulae (5.3.6 and 5.3.7).

Let us calculate the values of parameters γ_{stat} and φ_{stat} for each of the seven celestial regions separately. Afterwards we shall mark each corresponding position of the ecliptic pole in fig. 6.2. In the same illustration we shall also define the motion of the real ecliptic pole $P(t)$ that corresponds to the variations of the alleged dating.

In fig. 6.2 we have used the following segment as an example: it connects the ecliptic pole for celestial area B with the real ecliptic pole for epoch $t = 10$ marked $P(10)$. The length of this segment equals $\gamma^{B}_{stat}(10)$. The angle between this segment and the line that stands for arc $D(10)\ D'(10)$, whose defini-

tion was cited in relation to fig. 5.4 and 5.5; its value is equal to $\varphi^B_{stat}(10)$. Obviously enough, any other epoch can be taken as t, ditto area B, and respective values of γ_{stat} and φ_{stat} can be deduced with the aid of fig. 6.2.

Table 6.2 contains the values of $\gamma_{stat}(18)$ and $\varphi_{stat}(18)$ that we have calculated for each of the seven celestial regions. These positions provide an unambiguous definition of the "observer ecliptic pole" for each of the areas. However, we may have just as easily taken any pair of γ_{stat} and φ_{stat} values for a random t. We refer you further to section 5.4. Apart from that, table 6.2 contains the values of $\sigma_{init}(18)$ and the residual σ_{min} square average latitudinal discrepancies resulting from the compensation of the systematic error (see formulae 5.3.2 and 5.3.3). In section 5.4 we demonstrate that σ_{min} does not depend on time moment t under consideration, if we disregard the insubstantial influence of the proper star motion. Therefore, σ_{min} is defined by the ecliptic pole exclusively, which can be estimated statistically for this group of Almagest stars.

As for proper star motion, it has to be pointed out that it hardly affects either the estimated systematic error $\gamma_{stat}(t)$, $\varphi_{stat}(t)$ or the residual square average discrepancy of star coordinates in the Almagest catalogue. Therefore, we can omit all references to the effect of proper motion, although it was obviously always taken into account in our calculations.

We have chosen the value of $t = 18$ for table 6.2 just because this time moment corresponds to the Scaligerian dating of the Almagest.

Further on, Table 6.2 contains the following statistic characteristic of Almagest stellar coordinate precision. The value of $P_{init}(18)$ corresponds to the percentage of the stars whose latitudinal discrepancy doesn't exceed 10' for the dating of 100 A.D. ($t = 18$), 10' being the Almagest catalogue minimal scale step. The value of P_{min} corresponds to the share of the stars whose latitudinal discrepancy doesn't exceed 10' after the compensation of the systematic error. This value is hardly affected by the dating of the observations for large quantities of stars as considered presently.

The disposition of the statistically definable Almagest poles shown in fig. 6.2 as related to the trajectory of the true pole's motion tells us that in every celestial area except C the systematic error of the Almagest catalogue makes the catalogue "more ancient" even as compared to the epoch of Hipparchus. Let us re-

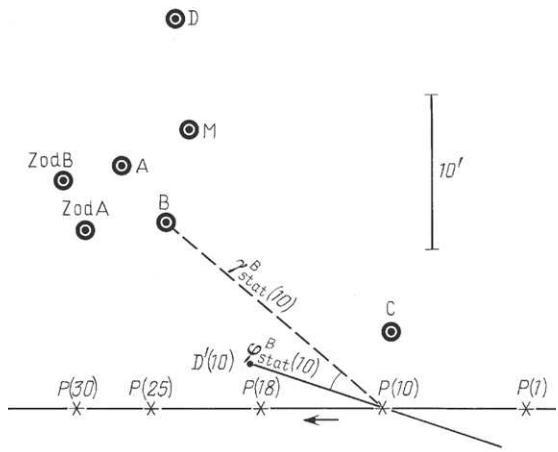


Fig. 6.2. The respective disposition of the mobile ecliptic pole $P(t)$ and the ecliptic poles as estimated for each of the seven parts comprising the Almagest catalogue.

Characteristics	*Areas of the Almagest sky*						
	A	*B*	*C*	*D*	*M*	*ZodA*	*ZodB*
$\gamma_{stat}(18)$	18.5	13.6	9.7	26.6	19.4	16.4	20.0
$\varphi_{stat}(18)$	34.0	–34.5	–122.5	–52.7	–50.5	–21.7	–23.5
$\sigma_{init}(18)$	20.5	21.8	23.4	27.3	23.0	17.7	24.0
σ_{min}	16.5	19.2	22.5	24.4	20.5	12.8	19.3
$P_{init}(18)$, in %	36.5	35.5	33.6	28.7	37.2	30.6	30.9
P_{min}, in %	50.6	43.5	43.1	35.7	45.7	63.7	44.0

Table 6.2. Calculated values of error parameters $\gamma_{stat}(18)$ and $\varphi_{stat}(18)$ as specified in the Almagest for different celestial regions.

mind the reader that the system error minimum in celestial region *C* falls over $t \sim 10$, or the year ~900 (900 A.D.). Still, as we have mentioned above, the disposition of the pole of "Ptolemy's Ecliptic" isn't in any way related to the date of the catalogue's compilation. This disposition simply tells us the character and the value of the systematic error made by Ptolemy in the measurements of star coordinates as conducted for one celestial region or another.

Another implication made by fig. 6.2 is that the statistically estimated pole positions for regions *A*, *ZodA* and *ZodB* are rather close to each other – in other words, Ptolemy appears to have made the same systematic error for each of these celestial regions. We shall come back to this fact below, in our analysis of individual Almagest constellations. Furthermore, the ecliptic pole defined by region *B* of the Almagest catalogue is also located next to the pole for groups *A*, *ZodA* and *ZodB*, as we see from fig. 6.2. The position of the pole for area *M* lays further away, and that of area *D* – even further off. Apparently, the systematic error of the Almagest's areas *M* and *D* has a different value than that of area *ZodA*. Area *C* looks like an obvious "reject" in fig. 6.2.

2.3. The calculation of confidence intervals

In the previous section we calculated discrete statistical estimates γ_{stat} and φ_{stat} for the unknown parameters of the Almagest catalogue's systematic error (γ and φ). We have already reminded the reader the definition of confidence intervals in section 5.5. Let us make the visual representation of the result as follows. First we shall build dependence graphs for t and the estimates of $\gamma_{stat}(t)$ and $\varphi_{stat}(t)$, where $1 \leq t \leq 25$. Then we shall draw stripes on the resulting graphs, whose vertical sections shall be the confidence intervals $I_\gamma(\varepsilon)$ and $I_\varphi(\varepsilon)$ with confidence level $\varepsilon = 0.1$. Confidence intervals shall be calculated in accordance with the formulae 5.5.10 and 5.5.11.

The result of these calculations can be seen in figs. 6.3-6.9. More data on the borders of different confidence levels ε and the two values of the alleged Almagest catalogue dating ($t = 7$, or 1200 A.D., and $t = 18$, or 100 A.D.) can be found in table 6.3. This table contains the values of half-widths of confidence intervals $I_\gamma(\varepsilon)$. Let us remind the reader that the centre of the confidence interval for γ and each fixed value of t is the non-shifted estimate of $\gamma_{stat}(t)$, qv in section 5.5.

		1200 A.D.				*100 A.D.*			
Area ↓	ε →	*0.1*	*0.05*	*0.01*	*0.005*	*0.1*	*0.05*	*0.01*	*0.005*
A	x_ε^γ	2.6	3.1	4.1	4.5	2.7	3.2	4.2	4.6
	x_ε^φ	11.7	14.0	18.3	20.0	16.6	19.8	25.9	28.4
B	x_ε^γ	2.7	3.2	4.2	4.6	2.6	3.1	4.0	4.4
	x_ε^φ	14.7	17.4	22.8	25.0	22.1	26.2	34.4	37.6
C	x_ε^γ	4.6	5.5	7.2	7.9	5.1	6.0	7.9	8.7
	x_ε^φ	91.1	108.2	141.9	155.2	60.7	72.2	94.7	103.5
D	x_ε^γ	6.3	7.4	9.8	10.7	7.2	8.6	11.3	12.3
	x_ε^φ	28.3	33.6	44.1	48.2	37.8	44.9	58.9	64.4
M	x_ε^γ	5.4	6.4	8.5	9.2	6.5	7.7	10.1	11.0
	x_ε^φ	28.2	33.5	43.9	48.0	42.4	50.3	66.0	72.2
Zod A	x_ε^γ	2.5	2.9	3.9	4.2	2.5	3.0	4.0	4.3
	x_ε^φ	11.4	13.6	17.8	19.5	18.1	21.5	28.2	30.8
Zod B	x_ε^γ	3.5	4.2	5.5	6.0	3.4	4.1	5.4	5.9
	x_ε^φ	14.3	17.0	22.3	24.4	19.8	23.5	30.8	33.7

Table 6.3. Semi-width values x_ε^γ of confidence interval $I_\gamma(\varepsilon)$ and x_ε^φ of confidence interval $I_\varphi(\varepsilon)$ for different confidence levels of ε and two presumed datings of the Almagest catalogue – 1200 A.D. ($t = 7$) and 100 A.D. ($t = 18$).

The confidence interval $I_\varphi(\varepsilon)$ for φ is, generally speaking, asymmetrical in relation to $\varphi_{stat}(t)$, since this estimate might be shifted. However, the abovementioned asymmetry is insignificant enough, and one may consider $\varphi_{stat}(t)$ the approximate centre of the confidence interval. x_ε^γ stands for the semi-width of interval $I_\gamma(\varepsilon)$, and x_ε^φ – for the semi-width of interval $I_\varphi(\varepsilon)$.

The figures one finds in tables 6.2 and 6.3 imply the following. Almagest area *ZodA* is the most accurately measured celestial region. This is obvious from the fact that the compensation of the discovered systematic error for this group of stars allows reducing the square average error to 12.8'. Also, it turned out that 64% of the stars ended up with a latitudinal discrepancy of less than 10'.

The second most precise group of stars pertains to the Almagest area *A*, where the square average latitudinal discrepancy became reduced to 16.5' after the compensation of the systematic error. The share of stars whose latitudinal discrepancy is under 10' has grown to over 50% in this area.

Confidence intervals $I_\gamma(\varepsilon)$ and $I_\varphi(\varepsilon)$ for celestial areas *ZodA* and *A* turned out to be of similar sizes, qv in table 6.3, although the precision of measurements is higher in area *ZodA*. This is explained by the heterogeneous quantities of stars for these parts. The less stars, the greater the size of the confidence interval; the latter is reduced by higher measurement precision.

The data from Table 6.2 confirm Ptolemy's claimed precision of 10', insofar as stellar latitudes are concerned, at least.

The next best measured groups of Almagest stars are concentrated in areas *B* and *ZodB*. Their precision characteristics are rather close to each other. The residual square average error is approximately equal to 19'. Stars with a latitudinal discrepancy of under 10' constitute 44% of these groups. The positions of the ecliptic pole calculated by these Almagest sky parts seem close to the pole positions of areas *A* and *Zod A* at a cursory glance; however, they end up in respective confidence intervals only with sufficiently small values of $\varepsilon \approx 0.01$, which means that the systematic errata of celestial areas *B* and *ZodB* may differ from those of *A* and *ZodA*. Moreover, the stars in areas *A* and *ZodA* were measured with substantially greater precision than those in areas *B* and *ZodB*. Below we shall cite more evidence that testifies to this.

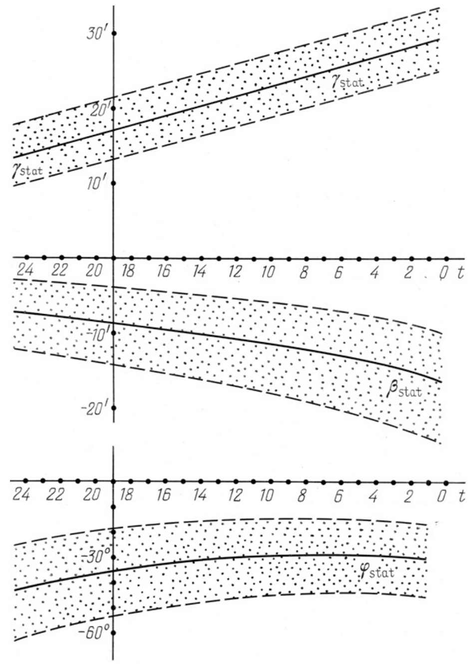


Fig. 6.3. The behaviour of systematic errors $\gamma_{stat}(t)$, $\varphi_{stat}(t)$ and $\beta_{stat}(t)$ for celestial region *A* in the Almagest.

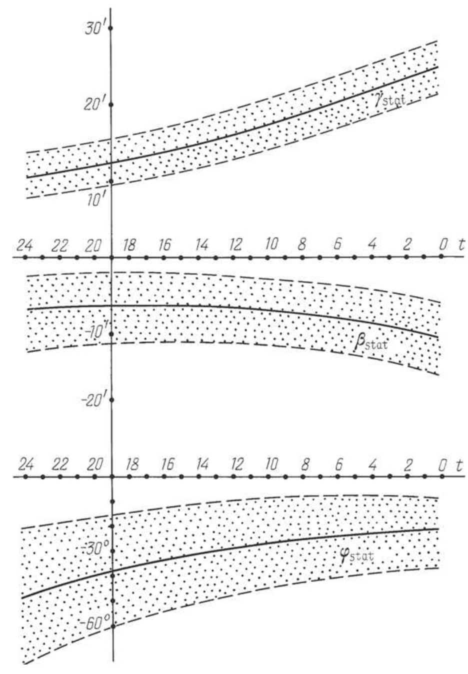


Fig. 6.4. The behaviour of systematic errors $\gamma_{stat}(t)$, $\varphi_{stat}(t)$ and $\beta_{stat}(t)$ for celestial region *B* in the Almagest.

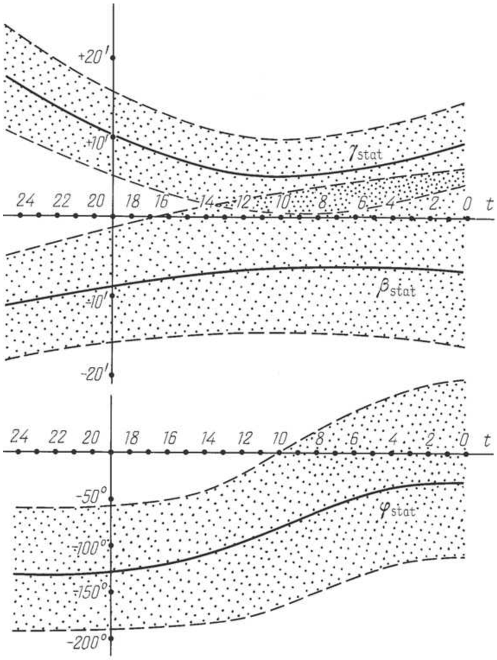


Fig. 6.5. The behaviour of systematic errors $\gamma_{stat}(t)$, $\varphi_{stat}(t)$ and $\beta_{stat}(t)$ for celestial region *C* in the Almagest.

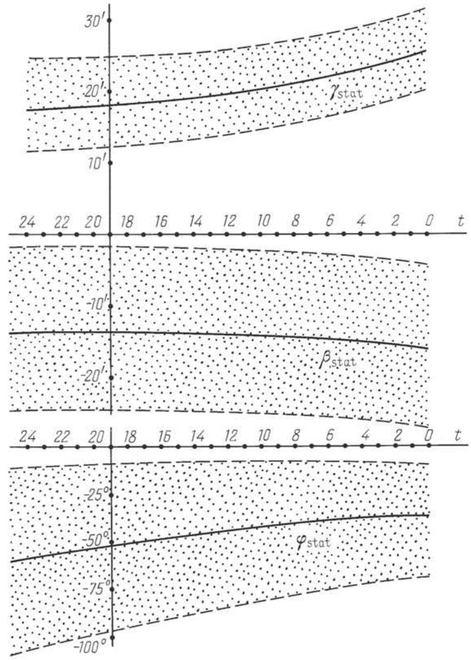


Fig. 6.7. The behaviour of systematic errors $\gamma_{stat}(t)$, $\varphi_{stat}(t)$ and $\beta_{stat}(t)$ for celestial region *M* in the Almagest.

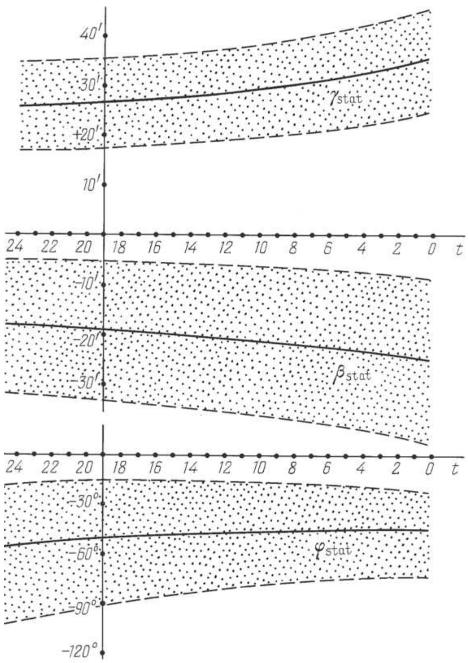


Fig. 6.6. The behaviour of systematic errors $\gamma_{stat}(t)$, $\varphi_{stat}(t)$ and $\beta_{stat}(t)$ for celestial region *D* in the Almagest.

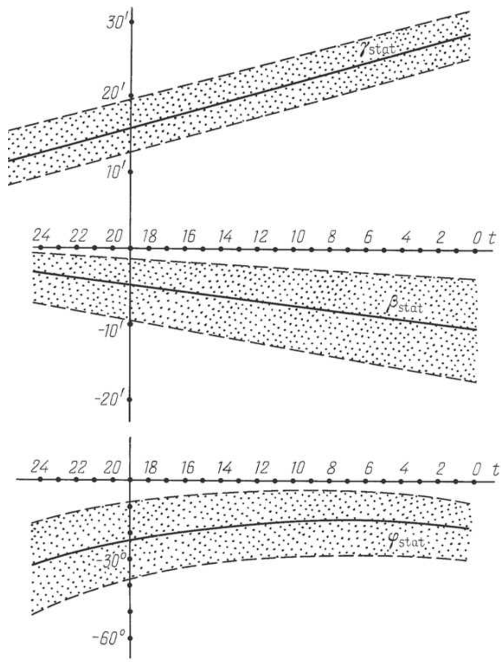


Fig. 6.8. The behaviour of systematic errors $\gamma_{stat}(t)$, $\varphi_{stat}(t)$ and $\beta_{stat}(t)$ for celestial region *ZodA* in the Almagest.

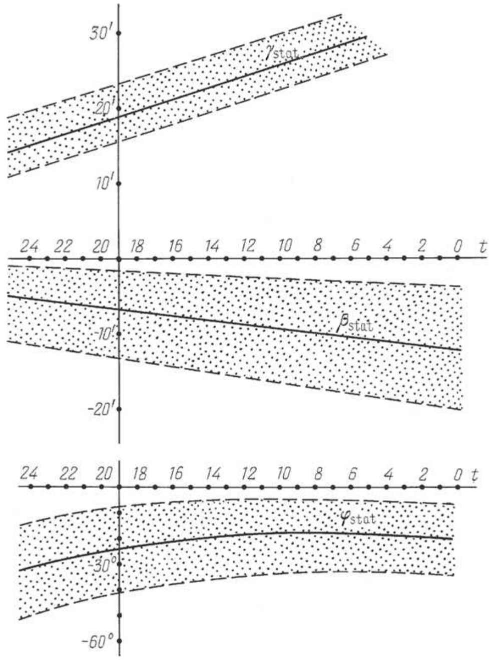


Fig. 6.9. The behaviour of systematic errors $\gamma_{stat}(t)$, $\varphi_{stat}(t)$ and $\beta_{stat}(t)$ for celestial region *ZodB* in the Almagest.

Parameters		*Celestial region in the Almagest atlas*	
		ZodA	*A*
a_{11}		1.11	0.82
a_{12}		0.042	–0.03
a_{22}		0.073	0.13
σ_{min}		12.8'	16.5'
$\Delta\sigma$	$\varepsilon = 0.1$	1.3'	1.2'
	$\varepsilon = 0.05$	1.8'	1.7'
	$\varepsilon = 0.01$	3.0'	1.8'
	$\varepsilon = 0.005$	3.5'	3.3'
σ_{max}	$\varepsilon = 0.1$	14.1'	17.7'
	$\varepsilon = 0.05$	14.6'	18.2'
	$\varepsilon = 0.01$	15.8'	19.3'
	$\varepsilon = 0.005$	16.3'	19.8'

Table 6.4. The values of $a(11)$, $a(12)$ and $a(22)$ as calculated for the Almagest, assuming the date of its compilation to be close to 100 A.D. ($t = 18$).

The stars in areas *C, D* and *M* were measured worse than those in areas *A* and *B*. Moreover, the values of γ_{stat} and φ_{stat} estimates only end up inside confidence intervals of areas *A, ZodA, B* and *ZodB* when the values of ε are very small indeed, which means that we must allow for the existence of such systematic errata in areas *C, D* and *M* that differ from the systematic errors pertinent to celestial regions *A, ZodA, B* and *ZodB*.

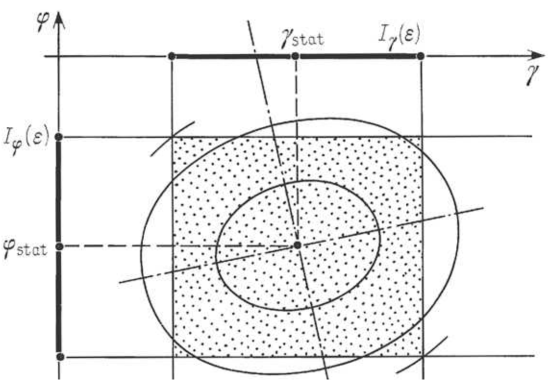


Fig. 6.10. Estimating the allowable variations of the square average latitudinal discrepancy values.

The analysis of tables 6.2 and 6.3 has already made us enquire about the values of the square average error that one should consider great and small. Let us refer to the sensitivity analysis as described in Chapter 5. The solution scheme can be seen in fig. 6.10.

Let us draw the ellipsoidal level curves of function σ^2 (γ, φ, t) on coordinate plane (γ, φ) according to formula 5.3.9. We shall draw the rectangle $R(\varepsilon)$ on the same plane, with coordinate projections $I_\gamma(\varepsilon)$ and $I_\varphi(\varepsilon)$. In fig. 6.10 it is the shaded rectangle. In this case, the probability that the true value of system error (γ, φ) lays inside this rectangle is $1 - 2\varepsilon$ or greater. Let us find $\sigma^2_{max}(\varepsilon) = max\,\sigma^2\,(\gamma, \varphi, t)$, where the maximum is taken for each of the pairs $(\gamma, \varphi) \in R(\varepsilon)$. The resulting value of $\sigma_{max}(\varepsilon)$ defines the permissible square average discrepancy with a confidence level of $1 - 2\varepsilon$, whereas the difference of $\sigma_{max}(\varepsilon) - \sigma_{min}$ defines the permissible expansion of the square average discrepancy due to the lack of sufficient precision in the estimation of parameters γ and φ by the values of γ_{stat} and φ_{stat}.

Table 6.4 contains the values of a_{11}, a_{12}, a_{22} for celestial areas *A* and *ZodA* for the time moment of $t = 18$; they define the level curves of the square average error. These level curves are calculated with the aid of formula 5.3, which stipulates the measurement of γ in arc minutes and φ in degrees. The table also contains the values of $\Delta\sigma = \sigma_{max}(\varepsilon) - \sigma_{min}$ calculated for the "extreme" values of $\varepsilon = 0.1$ and $\varepsilon = 0.005$. It has to be said that the resulting values appear to change little over time. These figures demonstrate the obvious precision division between areas *A* and *ZodA* on the one hand, and *B* and *ZodB* on the other. Indeed, even with the confidence level of $1 - 2\varepsilon = 0.99$, the square average error value of the confidence area constructed for the region *ZodA* remains less than the minimal error value of celestial regions *B* and *ZodB*.

A similar statement shall also be true for celestial region *A*. Although σ^A_{max} of region *A* is greater than σ^B_{max}, this is only true for $\varepsilon \leq 0.01$. Other values make error levels of celestial regions *A* and *B* substantially different, or separated by a statistical criterion. It must be added that the stars in the *ZodA* group are just as different from their counterparts from group *A* precision-wise, since for all ε values considered the value of σ_{max} found for *ZodA* is less than σ_{min} calculated for region *A*.

Furthermore, table 6.3 demonstrates that the parameter φ_{stat} cannot be calculated with sufficient precision, especially for the "poor quality" regions *C, D* and *M*. This is confirmed by the sizes of confidence intervals $I_\varphi(\varepsilon)$. For example, the full range of this interval exceeds 180 degrees in case of area *C*.

3. OUR ANALYSIS OF INDIVIDUAL ALMAGEST CONSTELLATIONS

3.1. The compiler of the Almagest may have made a different error in case of every minor constellation group

Further analysis is necessary due to the following problem. Parameters γ_{stat} and φ_{stat}, which define the systematic error, have been found for some large group of stars. They correspond to the turn of the ecliptic that minimises the square average discrepancy for the stars contained in this group. However, one must not a priori exclude the possibility that the compiler made a separate group error in case of every small star group such as an individual constellation. In this case, parameters γ_{stat} and φ_{stat} are but average meanings of the true group errata, and will be of little use to us for this reason.

We have to note that the sizes of confidence intervals for the values of φ_{stat} found in Section 2 are rather substantial. This may be explained by the low sensitivity of latitudinal discrepancies to the turn angle φ as well as the "non-systematic" nature of the φ_{stat} error. In other words, it is possible that parameters γ_{stat} and φ_{stat} have a different nature, namely, γ_{stat} is the result of an observer's error that affects all stars (an error in the estimation of the ecliptic's position), whereas φ_{stat} is the averaged value of numerous individual errors. Such a difference in the behaviour of the parameters is easy to explain if we consider the primary astronomical instrument of the Almagest epoch, for instance – the armillary sphere (see Chapter 1). The angle between the equatorial and ecliptic plane is fixed once and forever in the very construction of this instrument. If there was an defect in the latter, it would affect the coordinates of each and every star measured with the aid of this armillary sphere. The error in the estimated value of angle φ is of an altogether different nature. It is individual for each star and changes as the observer measures the coordinates of several consecutive stars.

One must therefore find the group errors characteristic for individual Almagest constellations and compare them to the systematic error of *ZodA*, the best measured group of Almagest stars.

3.2. The calculation of systematic errors for individual groups of constellations in the Almagest

The present section analyses a total of 21 small groups of Almagest stars. Their list can be found in Table 6.5, whose structure is completely identical to that of Table 6.1. Our only additional indication concerns the principle of selecting limited stellar configurations. All of the above are zodiacal constellations from the Almagest, likewise the environs of named stars, with the exception of Canopus and Previndemiatrix (made for abovementioned reasons), as well as Procyon, due to the paucity of stars in its environment.

Almagest star group	*Bailey's star numbers for the group*	*Number of stars in a group*
1. Zodiacal constellations		
Aries	362-371, 373, 374	12
Taurus	380-388, 390, 391, 393-410	29
Gemini	424-440	17
Cancer	449-454	6
Leo	462-481, 483-488	26
Virgo	497-516, 518-520	23
Libra	529-534	6
Scorpio	546-565	20
Sagittarius	570-573, 575-583, 585, 586, 590, 591, 593, 594, 596-598	22
Capricorn	601-608, 610-627	26
Aquarius	629-650, 652-656, 658-660, 662-668	37
Pisces	674-695, 697, 699-701, 704-706	29
2. Environs of named Almagest stars		
Antares	546-569	24
Cappella	220-233	14
Aquila	286-300	15
Vega = Lyra	149-158	10
Arcturus	88-96, 98, 100-110	21
Sirius	812, 818-835, 837-846	29
Spica	497-503, 505-515, 518-526	27
Regulus	462-481, 483-488, 491-493	29

Table 6.5. Stellar compound of 21 Almagest star groups; for each of the latter, the values of systematic (group) errors were calculated. These groups include all the zodiacal constellations of the Almagest, as well as the neighbourhood of 12 named Almagest stars, with the exception of Canopus and Previndemiatrix. The table contains Bailey's enumeration, or star numbers as given in the Almagest catalogue.

The location of group errors for individual Almagest constellations is associated with the following problems. Let us consider a certain star group G and find the corresponding values of γ^G_{stat} and φ^G_{stat} by applying the method of minimal squares. This will also define the minimal possible residual square average discrepancy σ^G_{min}, as well as the share of stars whose residual latitudinal discrepancy is less than 10'. This will also define P^G_{min} in relation to the time moment $t = 18$. However, due to the small sizes of certain star groups, the statistical discrepancy of estimates γ^G_{stat} and φ^G_{stat} is too great to serve as a basis for justified corollaries.

However, the value of σ^G_{min} defines the lower boundary of possible square average errata for group G. This minimal value of possible error results from turning the coordinate system by angles γ^G_{stat} and φ^G_{stat}. Obviously enough, the values of γ^G_{stat} and φ^G_{stat} can greatly differ from those of γ_{stat} and φ_{stat}, which were calculated for a larger number of stars that had included group G.

The identity criterion of group error for group G and the systematic error calculated for a large number of stars could be expressed as the approximated equation $\sigma^G_{min} \approx \sigma^G_1$, where σ^G_1 is the residual square

average discrepancy for group *G* after the coordinate system is rotated by angles γ_{stat} and φ_{stat}. Indeed, the above approximated equation means that γ_{stat} and φ_{stat} are "almost" optimal values. In order to support this criterion, let us define the auxiliary values of P^G_{min} and P^G_1, which stand for the share of stars from group *G* whose latitudinal discrepancy does not exceed 10' after the respective rotations of (γ^G_{stat} and φ^G_{stat}) and (γ_{stat} and φ_{stat}). Should we also observe a case of $P^G_{min} \approx P^G_1$, we can conclude that group *G* does indeed possess the same systematic error value as the stars of a greater group. We must note that the latter approximate proportion is not implied by the former, but happens to prove our claim independently. It also needs to be pointed out that both proportions are temporally independent, if we are to disregard the proper star motion. Therefore, their practical verification can only be conducted for a single moment in time – any one such moment, that is.

We have calculated the values of σ^G_1 and P^G_1 for different Almagest groups *G* and the time moment of $t = 18$. Let us reiterate that these values equal to the respective square average latitudinal discrepancy and the share of stars whose latitudinal discrepancy value does not exceed 10', given that the pole of the ecliptic coincides with the pole defined for the most accu-

Star group	*Indication of G*	σ^G_{init}	σ^G_{min}	σ^G_1	P^G_{init}	P^G_{min}	P^G_1
1. Zodiacal constellations							
Aries	Z1	19.7	17.2	18.9	45.5	45.5	72.7
Taurus	Z2	23.2	18.1	20.6	27.6	41.4	41.4
Gemini	Z3	17.8	10.5	11.0	29.4	82.4	58.8
Cancer	Z4	13.8	4.3	5.2	33.3	100.0	100.0
Leo	Z5	20.2	11.1	11.2	19.2	65.4	65.4
Virgo	Z6	18.4	13.6	14.4	39.1	56.5	47.8
Libra	Z7	8.4	6.1	9.3	83.3	83.3	83.3
Scorpio	Z8	18.8	13.7	15.1	30.0	65.0	55.0
Sagittarius	Z9	16.4	14.3	15.8	30.4	60.9	60.9
Capricorn	Z10	16.2	10.6	11.3	42.3	65.4	57.7
Aquarius	Z11	28.6	17.3	19.2	18.4	44.7	44.7
Pisces	Z12	22.5	21.5	21.7	51.7	41.4	34.5
2. Environs of named Almagest stars							
Antares	S1	17.7	12.6	13.8	33.3	70.8	58.3
Acelli	S2	15.7	11.0	12.1	33.3	58.3	66.7
Cappella	S3	34.6	30.3	34.0	35.7	14.3	64.3
Aquila	S4	24.0	23.7	26.7	40.0	33.3	13.3
Vega = Lyra	S5	20.0	14.1	17.1	50.0	60.0	30.0
Arcturus	S6	24.2	17.2	20.0	19.0	38.1	28.5
Sirius	S7	15.2	11.9	25.9	47.4	52.6	15.8
Spica	S8	17.9	14.1	14.5	44.4	48.1	48.1
Regulus	S9	25.2	21.0	21.1	17.2	58.6	58.6

Table 6.6. Calculation results for the 21 Almagest star groups. Here σ^G_{init}, σ^G_{min}, σ^G_1 correspond to square average latitudinal discrepancies in group *G* – the initial and the remaining, as well the one that we come up with after compensating the systematic error in *G* as estimated for *ZodA*. We also cite the stellar percentage values of P^G_{init}, P^G_{min}, P^G_1 with a minimal latitudinal discrepancy of 10'.

rately measured group of stars in area *ZodA*. In other words, the condition is that the group errors must equal the values of γ^{ZodA}_{stat} and φ^{ZodA}_{stat}.

The square average latitudinal discrepancy and the percentage of stars whose latitudinal discrepancy value doesn't exceed 10' (in group *G*, without the compensation of the systematic error) were transcribed for $t = 18$ as σ^G_{init} and P^G_{init}, respectively.

If the value of σ^G_1 exceeds the minimal possible value of σ^G_{min}, but very slightly so, we are entitled to assume that the group error value of star group *G* equals the systematic error value of celestial region *ZodA*. The difference between the values of P^G_1 and P^G_{min} is yet another proximity criterion for group error and systematic error. Let us remind the reader that the values σ^G_{min} and σ^G_1 are temporally independent for the immobile stars and only marginally depend on time in case of their mobile counterparts. A similar statement shall be true for the stars that end up within the 10' interval of the latitudinal discrepancy.

Table 6.6 contains the numeric data that we have calculated. A more visual representation thereof can be found in figs. 6.11 and 6.12. Fig. 6.11 contains the information about the values of σ^G_{min} and σ^G_1, as well as P^G_1 and P^G_{min}, for all the zodiacal constellations of the Almagest (indicated Z1, … , Z12). Fig. 6.12 contains respective results for the environs of the named Almagest stars; they are marked S1, … , S9. One must say that the environs of the named Zodiacal stars in the Almagest do not fully correspond with the respective Zodiac constellation. These environs are constituted by a group of stars from this constellation, which have received a name in Bayer's system. These stars are usually the brightest and the most reliably identifiable stars of the Almagest, which makes them more solid corollary basis.

3.3. Group errors for individual constellations from the well measured celestial region of the Almagest are virtually identical to the systematic error discovered as a characteristic of this area in general

The key implication of the cited graphs and of Table 6.6 is that the zodiacal constellations from celestial region *ZodA* (namely, Gemini, Cancer, Leo, Virgo, Libra and Scorpio) possess the following remarkable quality in the Almagest. The square average error σ_1 and the percentage of stars with the maximal latitudinal discrepancy of 10' calculated under the assumption that the group error is equal to (γ^{ZodA}_{stat}, φ^{ZodA}_{stat}) are only marginally different from the values of σ_{min} and P_{min} calculated for the optimal ecliptic pole position in the constellation under study. The greatest discrepancy between the two was noted in the "most orderly" constellation of Libra, where no value of σ_{init}, σ_{min} or σ_1 exceeds 10', and $P_{init} = P_{min} = P_1 = 83{,}3\%$. Such is the percentage of stars whose latitudinal discrepancy value is less than 10'. The equation $P_{init} = P_{min} = P_1$ is easy to explain – the constellation in question all but lays on the equinoctial axis, thus remaining quite unaffected by the turn.

However, this corollary may also be true for the constellations from celestial region *ZodB*, although with more details to take into account. However, the veracity or inveracity of this corollary is of no importance to us presently, since celestial region *ZodB* doesn't contain any named Almagest stars.

We must nevertheless point out a single curious fact that was found out in relation to the constellation of Aries. Although the value of σ_1 became lower in comparison to σ_{init} after the compensation of the systematic error discovered earlier (one must also note that the difference between σ_{min} and σ_{init} is rather small), but $P_1 >> P_{init} = P_{min}$ – in other words, the shift of the ecliptic pole into the position calculated for *ZodA* made it possible to raise the share of well-measured Almagest stars in the constellation of Aries to 72.7%.

The general conclusion resulting from our the consideration of all zodiacal constellations is as follows. If the proportion $\sigma_{min} << \sigma_{init}$ is true for the optimal value of σ_{min}, the conjecture that the group error equals the systematic error for celestial region *ZodA* and the ensuing compensation of this error lead us to the proportion of $\sigma_1 << \sigma_{init}$; other valid proportions include $P_1 >> P_{init}$ and $P_{min} >> P_{init}$. This is true of the following Almagest constellations: Gemini, Cancer, Leo, Virgo, Scorpio, Capricorn and Aquarius.

If the value of σ_{min} is close to σ_{init}, $\sigma_{min} \le \sigma_1 \le \sigma_{init}$ as a rule, and the effect of placing the ecliptic pole into the position that corresponds to area *ZodA* is hardly manifest at all. This is true of the Aries constellation

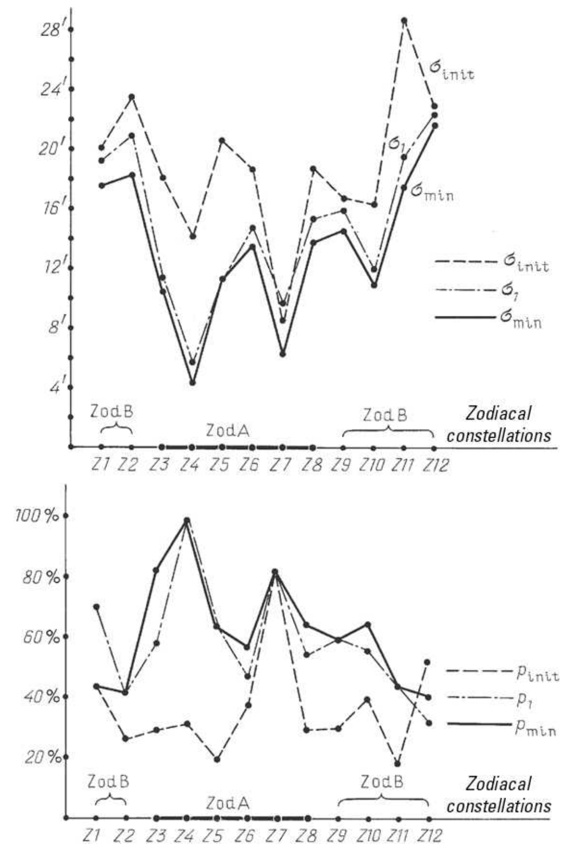


Fig. 6.11. The dependencies of σ_{min}, σ_1, σ_{init}, P_{min}, P_1, P_{init} for the zodiacal constellations.

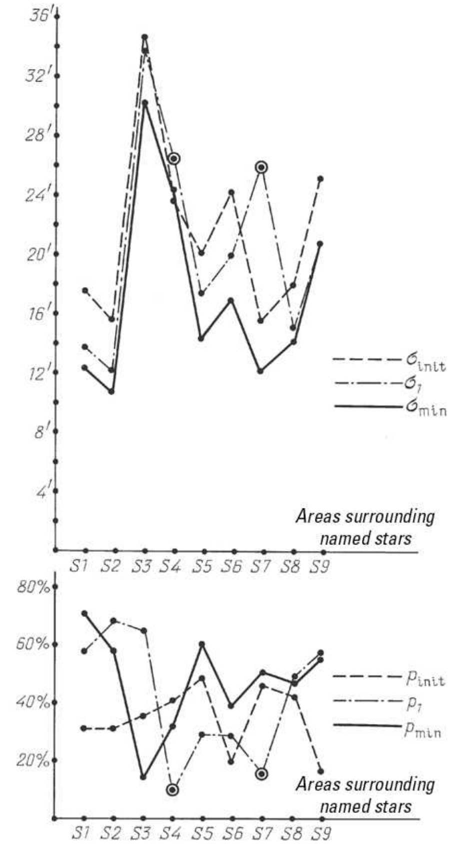


Fig. 6.12. The dependencies of σ_{min}, σ_1, σ_{init}, P_{min}, P_1, P_{init} for the areas around named stars.

(as we have pointed out, the percentage of well-measured stars grew dramatically in case of Aries), as well as Taurus, Libra, Sagittarius and Pisces.

Out of the constellations pointed out above, good precision characteristics of Libra from celestial area *ZodA* remain virtually unchanged after the shift of the ecliptic pole from the optimal position to the position that corresponds to *ZodA*. Precision characteristics of Aries become even better after this operation, and those of all the other constellations remain average.

Taurus is a typical example, with $\sigma_{init} = 23.2'$, $\sigma_{min} = 18.1'$, $\sigma_1 = 20.6'$, $P_{init} = 27.6\%$ and $P_{min} = P_1 = 41.4\%$. The constellation of Pisces differs from all the other Almagest constellations, with $P_{min} < P_{init}$ and $P_1 < P_{init}$, given that $\sigma_{init} \approx \sigma_{min} \approx \sigma_1$.

3.4. How the compensation of the systematic error that we have discovered affects the precision characteristics of the environs of named stars

The situation with the environs of named stars in the Almagest is more diverse. First of all, let us point out the environs of Aquila and Sirius. In both cases, the compensation of the discovered systematic error, characteristic for celestial region *ZodA*, leads to the following. Firstly, we observe a growth of the square average latitudinal discrepancy, which is rather substantial in case of Sirius – from 15.2' to 25.9'. Secondly, the share of well measured stars shrinks (from 40% to 13.3% for Aquila, and from 47.4% to 15.8% for Sirius). The obvious conclusion to make is that the

group error of the compiler made during the measurements of the environs of Aquila and Sirius is substantially different from the systematic error of celestial region *ZodA*. Unfortunately, it is impossible to calculate these errors veraciously. Therefore, Sirius and Aquila were excluded from further consideration.

The environs of other named stars have basically the same properties as the zodiacal constellations – namely, stars from the environs of Antares, Acelli, Arcturus, Spica and Regulus greatly reduce the square average error, bringing it close to the minimal possible values after the compensation of the group error, which equals the systematic error for region *ZodA*. The percentage of stars whose latitudinal discrepancy value is smaller than 10' (P_1) shall dramatically grow as compared to the initial value of P_{init}. The environs of Cappella have the same property as the constellation of Aries – namely, the square average latitudinal discrepancy of this area doesn't change much after the shift of the ecliptic pole from the initial position to the optimal position and then also into the position calculated for celestial region *ZodA*. However, in the last of said positions the share of stares that fit into the ten-minute latitudinal discrepancy value grew drastically in the vicinity of Cappella, reaching 64.3%. For comparison, let us point out that in the initial position this share equalled 35.7%, and as little as 14.3% in the optimal position dictated by the square average latitudinal discrepancy. On the contrary, the stars neighbouring with Vega demonstrated a substantial reduction of the square average latitudinal discrepancy. However, when we shifted the ecliptic pole into the position characteristic for celestial region *ZodA*, the number of stars with the latitudinal discrepancy value of 10 minutes and less was reduced substantially. Therefore, the nature of group errors in the environs of Vega and Cappella remains unclear. Little wonder – one might as well recollect that these stars lay at quite some distance from the celestial region of *ZodA*.

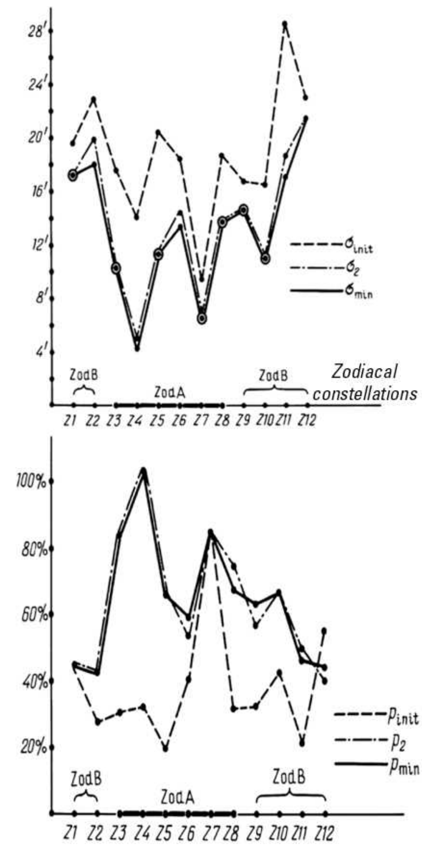


Fig. 6.13. The dependencies of σ_{min}, σ_2, σ_{init}, P_{min}, P_2, P_{init} for the zodiacal constellations.

3.5. The discovery of a single systematic error made by the compiler of the Almagest for the region of *ZodA* and the majority of named stars

Although we have discovered a certain proximity between the characteristics of σ_1 and P_1, respectively to σ_{min} and P_{min} (which testifies to the systematic nature of γ_{stat}), the issue of whether or not the error of φ_{stat} might be systematic as well remains open. Let us solve it in the following manner. Let us consider some individual Almagest constellation. We shall not go beyond the zodiacal constellations – the six named stars pertain to the Zodiac, at any rate. Let us calculate the characteristics of σ_2 and P_2 for these constellations, which can be done as follows. The first characteristic is the residual square average discrepancy, and the second – the share of stars in a constellation whose latitudinal discrepancy does not exceed 10'. Both characteristics result from the statistical error γ_{stat}^{ZodA}, calculated for region *ZodA*, and $\varphi^{(2)}$, calculated as a necessary pre-requisite for the minimization of the σ_2 error. In other words, this is what we come up with for constellation *G*:

$$\sigma_2^G = \sigma_2^G(t) = \min_{\varphi} \sigma^G(t) = \min_{\varphi} \sigma^G(\gamma_{stat}^{ZodA}, \varphi, t),$$

$$\varphi^{(2)} = \arg\min_{\varphi} \sigma^G(\gamma_{stat}^{ZodA}, \varphi, t).$$

Let us compile table 6.7, which is similar to table 6.6. Moreover, some data recur for better demonstrability. In table 6.7 the values of σ_1 and P_1 are replaced by σ_2 and P_2. Let us also draw these data as fig. 6.13, which is similar to fig. 6.11. Both the table and the drawing make it obvious that the compensation of systematic error γ_{stat}^{ZodA} in zodiacal constellations from celestial area *ZodA* and the variation of the φ value may give us minimal possible values of σ_2, which are very close to σ_{min} or even equal to σ_{min}. Likewise, the value of P_2 will be close to P_{min} or equal thereto. Remarkably enough, the same is true for the constellations from celestial region *ZodB*.

All of the above proves it beyond any doubt that the value of γ_{stat}^{ZodA} that we have discovered is indeed the systematic error made by the compiler of the Almagest catalogue as he measured the stars from celestial region *ZodA*, as well as named stars, with the exception of Sirius, Aquila and Canopus. The value of φ_{stat}^{ZodA} can be an averaged result of many individual measurement errors, and there is no reason to consider it a systematic error. Moreover, the value of φ_{stat} is calculated rather roughly, which makes it rather uninformative in this respect.

4. COROLLARIES

Corollary 1. It has been proven statistically that the ecliptic poles of stars from celestial regions *A* and *ZodA* are very close to one another, which makes the values of the systematic error made by the compiler of the Almagest in these parts of the sky the same.

Corollary 2. The statistical analysis that we have conducted gives one no reason to believe that the systematic error values of the Almagest catalogue for celestial regions *C, D, M, B* and *ZodB* have anything in common with such values characteristic for areas *A* and *ZodA*. Systematic errors of areas *C, D,* and *M* are very likely to differ from their counterparts in areas *A* and *ZodA*. We can say nothing of any substance about the errors that characterise celestial regions *B* and *ZodB* in the Almagest, since the numer-

Star group	*Indication of G*	σ_{init}^G	σ_{min}^G	σ_2^G	P_{init}^G	P_{min}^G	P_2^G
Zodiacal constellations							
Aries	Z1	19.7	17.2	17.2	45.5	45.5	45.5
Taurus	Z2	23.2	18.1	20.2	27.6	41.4	41.4
Gemini	Z3	17.8	10.5	10.6	29.4	82.4	82.4
Cancer	Z4	13.8	4.3	4.5	33.3	100.0	100.0
Leo	Z5	20.2	11.1	11.1	19.2	65.4	65.4
Virgo	Z6	18.4	13.6	14.4	39.1	56.5	52.2
Libra	Z7	8.4	6.1	6.1	83.3	83.3	83.3
Scorpio	Z8	18.8	13.7	13.7	30.0	65.0	70.0
Sagittarius	Z9	16.4	14.3	14.4	30.4	60.9	56.5
Capricorn	Z10	16.2	10.6	10.6	42.3	65.4	65.4
Aquarius	Z11	28.6	17.3	18.7	18.4	44.7	47.4
Pisces	Z12	22.5	21.5	21.7	51.7	41.4	37.9

Table 6.7. Calculation result for the zodiacal constellations of the Almagest. Here σ_{init}^G, σ_{min}^G, σ_2^G represent the square average latitudinal discrepancies in group *G* – the initial and the remaining, as well the one that we come up with after compensating the systematic error in *G* as estimated for *ZodA* with the optimal choice of parameter φ. We also cite the stellar percentage values of P_{init}^G, P_{min}^G, P_2^G, as calculated after similar compensation, with a minimal latitudinal discrepancy of 10'.

ical material that we have at our disposal doesn't permit anything in the way of an unambiguous statistical conclusion.

Corollary 3. The precision of star coordinate measurements is much higher for *A* and *ZodA* than it is in case of any other celestial region.

Corollary 4. The residual square average latitudinal discrepancy for celestial region *ZodA* equals 12.8' in the Almagest. About 2/3 of all stars from this part of the sky have the latitudinal discrepancy of less than 10', which make them fit the declared 10' precision margin of the Almagest catalogue. Corresponding values for celestial region *A* equal 16.5' and 1/2.

Corollary 5. A study of the Zodiacal constellations and the environs of named stars in the Almagest makes it possible to conclude that parameter γ, which stands for the error in the angle of the ecliptic, is a systematic error. As for parameter φ, it may well be a squared value of group or individual errors.

Corollary 6. Group error γ for the constellations of Gemini, Cancer, Leo, Virgo, Libra, Scorpio, Sagittarius and Capricorn, as well as the environs of Antares, Acelli, Arcturus, Spica and Regulus, happens to be close to the systematic error of γ_{stat}^{ZodA}, which is characteristic for *ZodA*, the part of the sky measured best in the Almagest, and might even coincide therewith.

Corollary 7. Nothing definite can be said about the values of group errors made by the compiler of the Almagest in cases of Aries and Taurus. They may coincide with the errata discovered for *ZodA* or be different from their values. The errata in the environs of the named stars Cappella and Vega cannot be calculated, either.

Corollary 8. Group errors in the environs of Sirius and Aquila differ from the error that is characteristic for celestial region *ZodA*. However, we haven't managed to calculate the values of these errors. The group error made for the constellation of Pisces is also likely to differ from γ_{stat}^{ZodA}.

CHAPTER 7

The dating of the Almagest star catalogue. Statistical and geometrical methods

1. THE CATALOGUE'S INFORMATIVE KERNEL CONSISTS OF THE WELL-MEASURED NAMED STARS

The analysis of the Almagest star catalogue related in Chapters 2-6 had the objective of reducing latitudinal discrepancies in star coordinates by compensating the systematic error as discovered in the catalogue.

As a result, we have proven that the Almagest compiler's claim about the precision margin of his measurements being less than 10' is justified – insofar as the latitudes of most stars from celestial area *A* are concerned, at least. We believe this circumstance to be of paramount importance.

However, we can only date the Almagest catalogue by considering fast and a priori precisely measurable stars. In other words, dating purposes require individual error estimates. Our statistical characteristics can tell us nothing about the precision of actual star coordinate measurements or the stars measured with the greatest precision.

The choice of such stars can only be defined by reasonable considerations based on known practical methods of measuring stellar coordinates as used by the ancients (see Chapter 1). It is known that the measurements of most stars' coordinates have always been based on the so-called reference stars, whose number is rather small as compared to the total number of the stars in the catalogue.

Let us begin by reiterating a number of considerations voiced in the preceding chapters, which will serve as a foundation of our dating method.

Unfortunately, we do not know which reference star set was used by the author of the Almagest. All we do know is that it must have included Regulus and Spica, since the measurement of their coordinates is discussed in separate dedicated sections of the Almagest. However, it would make sense to assume that the compiler of the catalogue was at his most accurate when he measured the coordinates of named stars. As it was stated above, there are twelve such stars in the Almagest: Arcturus, Regulus, Spica, Previndemiatrix, Cappella, Lyra = Vega, Procyon, Sirius, Antares, Aquila = Altair, Acelli and Canopus.

The identity of Ptolemy's reference stars (as used for planetary coordinate measurements) is an issue that was studied in [1120]. The stars in question turn out to be as follows (Ptolemy actually mentions them as ecliptic reference stars): Aldebaran = α Tau, Regulus, Spica and Antares. Three of them have proper names in the Almagest – namely, Regulus, Spica and Antares. Apparently, Ptolemy also had to add Aldeb-

aran to their number for the purpose of planetary observations. Incidentally, all four stars are included in our table 4.3.

The twelve named stars of the Almagest are bright, clearly visible against their background and providing a convenient basic set of reference points on the celestial sphere. The most important circumstance is that a sufficiently large part of these stars are characterised by substantial proper motion rates, especially Arcturus, Procyon and Sirius.

Seven of the named Almagest stars are located in celestial area *Zod A* or its immediate vicinity. They are as follows: Arcturus, Spica, Procyon, Acelli, Previndemiatrix, Regulus and Antares. Nine of the named stars surround area *A* – the above set needs to be complemented by Lyra = Vega and Cappella. Thus, even if these 12 stars weren't used for reference, their coordinates are still most likely to have been measured with sufficient precision.

However, despite the probable high precision of their coordinates as measured in the Almagest, the stars comprised in this group are by no means of equal importance. Our analysis has revealed the following:

1) Canopus is located far in the south, and measurement precision is greatly affected by refraction in such cases. Therefore, all efforts of the Almagest's compilers notwithstanding, the coordinates of this star as given in the catalogue are a priori known to be more than one degree off the mark.

2) The coordinates of Previndemiatrix as measured by the compiler of the Almagest remain unknown to us – we are only familiar with results of later research ([1339]).

3) Group errors in the environs of Sirius and Aquila fail to concur with the errata inherent in the coordinates of all the other stars, as we have discovered in Chapter 6. We are incapable of calculating the rates of these errors, and, consequently, compensation is a non-option in their case.

Thus, we end up with 8 named stars that we can use for the purpose of dating. The stars that surround them have a single group error in their coordinates – at least, the γ component of this error is the same in each and every case. We shall be referring to these stars as to the *informative kernel* of the Almagest catalogue.

It would make sense to put forth the following hypothesis. If the precision rate claimed by the compiler of the catalogue was actually true, it is guaranteed to manifest as such in the case of the catalogue's informative kernel after the compensation of the group error.

This is the very hypothesis that out method of dating star catalogues relies upon.

However, the fact that the informative kernel of a star catalogue has the ability to assist us with the dating of the latter is far from obvious. In general, the fact that we did manage to reconstruct the true values of random errors inherent in the Almagest catalogue by group error compensation does not imply that the individual errors in the coordinates of the catalogue's kernel stars are the same. It doesn't seem too likely that a discrepancy of this sort actually exists – the central star of a group appears to have the same sort of error in its coordinates as its closest neighbours. However, strictly speaking, the hypothetical existence of such a discrepancy has to be taken into account nonetheless. Apart from that, one mustn't rule out the possibility that the coordinates of a star included in the catalogue's informative kernel were measured with an error margin of more than 10'.

All of the above tells us that if we do manage to find a moment in time conforming to the requirements of our hypothesis, we shall once again prove the correctness of our initial statistical conjectures.

2. PRELIMINARY CONSIDERATIONS IN RE THE DATING OF THE ALMAGEST CATALOGUE BY THE VARIATIONS IN THE COORDINATES OF NAMED STARS

In section 1 we singled out a group of stats that we have called the Almagest's informative kernel. We shall consider its behaviour in detail below. What we shall analyse herein is the behaviour of all 12 named Almagest stars at once. This preliminary study demonstrates perfectly well how much greater the precision rate of the Almagest catalogue becomes after the compensation of its systematic error. It also provides additional explanation to the fact that three named stars out of twelve (Canopus, Sirius and Aquila = Altair) break the homogeneity of the entire sample. We learn

The name of a star and the respective Bailey's number	*Years*					
	1800 A.D.	*1400 A.D.*	*900 A.D.*	*400 A.D.*	*100 A.D.*	*200 B.C.*
Arcturus (110)	37.8	21.2	0.9	19.3	31.4	43.3
Sirius (818)	23.6	18.3	11.7	5.1	1.2	2.6
Aquila = Altair (288)	8.6	9.4	10.5	11.8	12.6	13.4
Previndemiatrix (509)	13	14.3	15.8	17.1	17.8	18.4
Antares (553)	32.6	29.5	25.5	21.6	19.3	17
Aselli (452)	30.5	28.5	25.9	23.2	21.5	19.8
Procyon (848)	11.2	16	21.9	27.6	31.1	34.4
Regulus (469)	17.5	16.6	15.4	14	13	12.1
Spica (510)	2.4	0.7	1.3	3.1	4.2	5.2
Lyra = Vega (149)	15.4	14.2	12.5	10.8	9.8	8.7
Capella (222)	21.9	21.7	21.3	21	20.8	20.6
Canopus (892)	51	54.2	58.2	62.3	64.8	67.3

Table 7.1. Latitudinal discrepancies of the 12 named Almagest stars and their dependency on the presumed dating. The systematic error discovered in the Almagest catalogue isn't compensated herein.

these stars to be "rejects" in relation to all the other named stars. Below in our study of all 12 named stars as a whole we shall be using the coordinates of Previndemiatrix from [1339] which were apparently calculated by Halley. We shall use $\Delta B_i(t, \gamma, \varphi)$ for referring to the difference between the latitude of star *i* from the informative kernel of the Almagest after the compensation of the systematic error (γ, φ) and the true latitude as calculated for epoch *t*.

Consideration 1. Let us observe the correlation between the latitudinal precision of the named stars' coordinates in the Almagest with the grade value of the catalogue equalling 10', assuming that the latter contains no global systematic errors. Table 7.1 contains the absolute latitudinal discrepancy values of all 12 named Almagest stars depending on the alleged dating *t*. In the first column we see the given star's Almagest number (in Bailey's numeration). The rates of latitudinal discrepancies are given in arc minutes.

Table 7.1 demonstrates that for 7 out of 12 named Almagest stars the latitudinal discrepancy exceeds the limit of 10'. The columns that correspond to 100 A.D., which is the Scaligerian dating of the Almagest (Ptolemy's epoch) or 200 B.C. (the epoch of Hipparchus) draw our attention primarily because of the outrageous error in the coordinates of Arcturus – around 30' or 40'. It is peculiar that the brightest and most visible star of the Northern hemisphere would be observed by either Ptolemy or Hipparchus this much worse than all the other stars. Furthermore, the text of the Almagest implies that the coordinates of Regulus were measured several times during the compilation of the catalogue, and that the star in question is known to have been one of the referential points for the measurement of all the other stars in the catalogue. It would be natural to expect that Ptolemy had been exceptionally careful in his measurement of this star; therefore, its latitudinal discrepancy shall be less than 10'. Let us point out that for another bright star on the ecliptic – namely, Spica, whose coordinates had also been measured by Ptolemy during the initial stage to be used for reference later (see Chapter VII.2 of the Almagest, or [1358]), has a latitudinal discrepancy of 5' – less than half the catalogue grade value.

Let us now consider the systematic error that we discovered in the Almagest (see Chapter 6). As the γ compound of this error only varies slightly over the interval between the beginning of the new era and the middle ages, and the variations of the φ value also hardly affect the picture, we shall use the values $\gamma_0 = 21'$, $\varphi_0 = 0$. The value $\gamma_0 = 21'$ is the average value of $\gamma(t)$ for *t* from the a priori known interval.

The name of a star and the respective Bailey's number	*Years*					
	1800 A.D.	*1400 A.D.*	*900 A.D.*	*400 A.D.*	*100 A.D.*	*200 B.C.*
Arcturus (110)	29.9	15.5	2.3	20	30.5	41
Sirius (818)	44.2	39.2	32.7	25.9	21.8	17.5
Aquila = Altair (288)	27	28.7	30.7	32.5	33.5	34.4
Previndemiatrix (509)	15.6	14.9	13.8	12.6	11.8	11
Antares (553)	13.3	11	8.5	6.2	4.9	3.7
Aselli (452)	13.2	10.2	6.5	2.9	0.9	1.1
Procyon (848)	8.1	4	1.2	6.7	10.1	13.5
Regulus (469)	6.1	3.5	0.4	2.7	5.1	6.2
Spica (510)	5.1	4.9	4.4	3.7	3.3	2.7
Lyra = Vega (149)	5.1	6.7	8.5	10	10.8	11.5
Capella (222)	1.3	1.5	2.1	2.9	3.5	4.2
Canopus (892)	71.5	75	79.2	83.1	85.4	87.6

Table 7.2. Latitudinal discrepancies of the 12 named Almagest stars and their dependency on the presumed dating as given after the compensation of the systematic error in the Almagest stellar coordinates specified by parameters $\gamma_0 = 21'$ and $\varphi_0 = 0$.

We shall proceed with building the table numbered 7.2, which is similar to 7.1, the sole difference being that the systematic error defined by parameters $\gamma_0 = 21'$ and $\varphi_0 = 0$ in all the stellar coordinates is now taken into account and compensated in the calculation of latitudinal discrepancies.

A comparison of the two tables demonstrates the precision characteristics of the named Almagest star coordinates to have improved drastically for all possible datings after the compensation of the systematic error. The latitudes of Regulus and Spica prove to be measured with the precision rate of up to 5' for every alleged dating between the beginning of the new era and the end of the Middle Ages. This correlates well with the fact that these two stars enjoy a great deal of attention in the text of the Almagest – qv in the book itself, Chapter VII.2 ([1358]). Moreover, if we are to place the dating on the interval of $6 \le t \le 10$, or 900-1300 A.D., the latitudinal discrepancy does not exceed 10', or the catalogue scale grade value, for 8 named stars out of 12 – the ones located in celestial area *A* which we discovered in Chapter 6 as we were analyzing the entire stellar aggregate of the Almagest catalogue.

It goes without saying that the above considerations need to be more explicit. In particular, we have to study other values of parameters γ and φ. The present chapter contains extensive calculations and more explicit statements below.

Consideration 2. The following line of argumentation might provide additional information pertinent to the dating of the Almagest catalogue. Let us consider the latitudinal discrepancies $\Delta B_i(t, \gamma, \varphi)$ of a certain Almagest star set E, $1 \le i \le n$ as a whole for each moment t and all the values of γ and φ. We shall use them for building empirical function graphs of latitudinal error distribution for star set E: $F_{t,\gamma,\varphi}(x) = (1 / n)\ \#\{i : |\Delta B_i(t, \gamma, \varphi)| \le x\}$, where n represents the quantity of stars in set E. A comparison of these distribution functions for different values of parameters t, γ and φ can allow us to try finding such a combination of these values that will minimize the latitudinal errors of set E stochastically. The error difference rate for different values of t, γ and φ shall be their average difference value. We can obviously come to no quantitative conclusions so far since we only have 12 observations at our disposal, and we shall thus be merely referring to the qualitative picture as a first approximation.

The error difference rate in question can be represented as the area contained between the distribution graphs of the functions $F_{t1,\gamma1,\varphi1}(x)$ and $F_{t2,\gamma2,\varphi2}(x)$

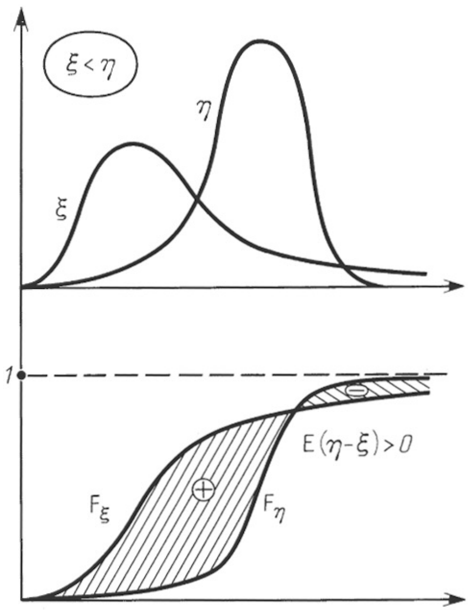


Fig. 7.1. Empirical functions of error distribution in stellar latitudes.

as drawn on a single draft. Both areas contained between the graphs have to be taken with either a plus or a minus depending on which function we find to the right and to the left of the area in question (see fig. 7.1). The distribution function $F_{t0,\gamma 0,\varphi 0}(x)$ that is located to the left of all the other functions $F_{t,\gamma,\varphi}$ on the average corresponds to minimal latitudinal error rates for set E. It would be natural to consider the dating t_0 and the systematic error value (γ_0, φ_0) as approximations to the real observation date and the real systematic error as made by the observer.

Let us illustrate the above with the example of another famous star catalogue dating to the second half of the XVI century and compiled by Tycho Brahe. The informative kernel that we shall be using is comprised of 13 named stars from Tycho Brahe's catalogue. We have calculated the empirical distribution functions $F_{t,\gamma,\varphi}$ for $\gamma = \varphi = 0$ and three different values of t: $t = 3$ (1600 A.D.), $t = 3.5$ (1550 A.D.) and $t = 4$ (1500 A.D.). The result can be seen in fig. 7.2. This illustration demonstrates quite well that without considering the possibility of a systematic error inherent in Tycho Brahe's catalogue ($\gamma = \varphi = 0$) epoch $t = 3.5$ proves to be the optimal dating of the catalogue (approximately 1550 A.D.). Indeed, this is the very dating for which the errors in the 13 named catalogue stars shall be minimal in the abovementioned sense. The date 1550 A.D. is really close to the known epoch when Tycho Brahe's catalogue was compiled, namely, the second half of the XVI century.

Let us provide a list of these 13 stars from Tycho Brahe's catalogue. First and foremost, they are Regulus, Spica, Arcturus, Procyon, Sirius, Lyra = Vega, Capella, Aquila and Antares, which are also included in the list of the named stars from the Almagest. Apart from that, there are four more stars: Caph = β Cas, Denebola = β Leo, Pollux = β Gem and Scheat = β Peg.

We shall now consider the empirical distribution functions $F_{t,\gamma,\varphi}$ for star set E that consists of 12 named Almagest stars (see section 1). In fig. 7.3 one sees the graphs of these functions for $t = 5$, or 1400 A.D., $t = 10$, or 900 A.D., $t = 18$, or 100 A.D., and $t = 20$, or 100 B.C. with varying values of γ. The value of φ is considered to equal zero everywhere, since the general picture is hardly affected by φ variations. The values $t = 10$, or 900 A.D., and $\gamma = 21'$ are optimal – that is to say, they generate the least serious errors.

The resulting graphical representations of the functions $F_{t,\gamma,\varphi}$ for the Almagest isn't very sensitive to changes in the contingent of the named stars. Let us cite the empirical distribution functions for all 13 stars which were used in the Tycho Brahe example, having taken the coordinates from the Almagest this time, qv in fig. 7.4. The values of $t = 10$ and $\gamma = 21'$ remain optimal for this star list as well. In fig. 7.4 one can clearly see the difference between the values of $\gamma = 21'$ and $\gamma = 0$ already pointed out above – namely, that all the graphs corresponding to $\gamma = 21'$ taken as a whole are located to the left of the graphs built for $\gamma = 0$ in general, indicating the lower error rate of the former as opposed to the latter. In other words, the value of $\gamma = 21'$ is "better" than $\gamma = 0$ for all the t dates from the a priori chosen interval.

Consideration 3. Let us conclude with discussing the issue of just how possible it is to expand the list of the named Almagest stars used as a basis for proper movement dating. Yet the coordinate precision of this expanded list (latitudinal at least) may by no means deteriorate. The first impression one gets is that the most natural way to extend the list would be includ-

ing all the stars which have names of their own nowadays into it (see table P1.2 in Annex 1). Most stars received names in the Middle Ages, but this practice continued into the XVII-XIX century. It is possible that many of them were particularly significant for the Almagest catalogue compiler. We shall proceed to select just those stars from table P1.2 (from Annex 1) whose names are capitalized in the exact same manner as [1197] does it; such are the most famous of the named stars. Their number is 37, qv listed in table 7.3.

However, it turns out that such an expansion of the Almagest's informative kernel drastically reduces the sample's coordinate precision, and we are particularly concerned about the latitudes being affected. Let us consider the "expanded kernel" that contains 37 Almagest stars as listed in table 7.3. Fig 7.5 demonstrates how the mean-square discrepancy behaves for these 37 stars depending on the alleged dating of the Almagest. Having calculated this discrepancy, we would allow for the variation of the systematic error's calculated rate to fluctuate within ±5' with the step value of 1 minute for parameter γ and within 30' with the step value of 1 minute for parameter β. The resultant graph demonstrates that although the minimum is reached around 400 A.D., it is very inexplicit. The minimal mean-square value roughly equals 18 minutes. If we are to allow for a variation of this value within a two-minute range, or a mere 10%, we shall end up with a "dating" interval of 1800 years, no less – between 600 B.C. and 1200 A.D. It is perfectly obvious that this result is of no interest to us, the reason being that the average precision of Ptolemy's calculations is too low for the 37-star list under consideration. It is clearly insufficient for the dating of the catalogue by proper star movements. Furthermore, this vague picture is what we get in our analysis of the latitudes, which are more precise in the Almagest catalogue, as we know. The longitudinal picture is even vaguer.

In figs. 7.6 and 7.7 one sees the dependency graphs for the quantity of stars in the extended kernel whose calculated latitudinal error does not exceed 10 and 20 minutes respectively and the presumed dating of the

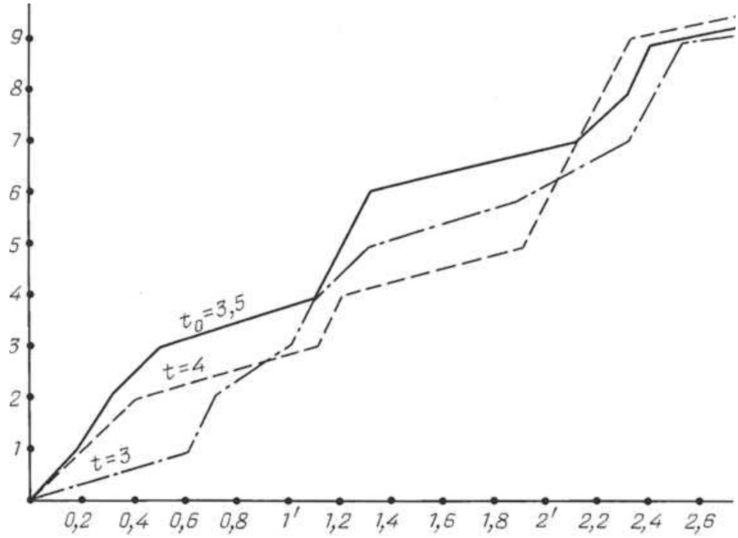


Fig. 7.2. Empirical distribution functions for Tycho Brahe's catalogue; the optimal value of $t_0 = 3.5$.

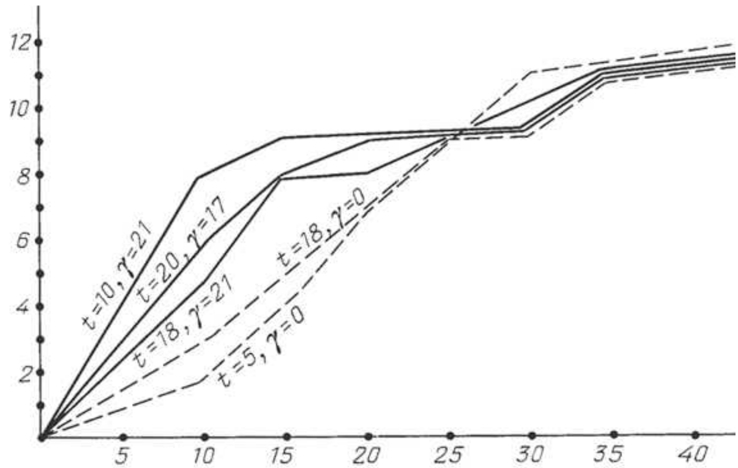


Fig. 7.3. Empirical distribution functions $F_{t,\gamma,\varphi}$ for the 12 named Almagest stars. The value of φ equals zero in every case.

No by BS4 and BS5	*Bailey's number*	*Stellar magnitude according to BS5*	v_δ*(1900) [1197]*	v_δ*(1900) [1197]*	*Stellar magnitude according to the Almagest*	*Modern name of the star and its ancient proper name as specified in caps in the Bright Stars Catalogue ([1197]), which indicates that the star in question was known very well in the past*
5340	110	–0.04	–1.098	–1.999	1	16Alp Boo (ARCTURUS)
1708	222	0.08	+0.080	–0.423	1	13Alp Aur (CAPELLA)
3982	469	1.35	–0.249	+0.003	1	32Alp Leo (REGUL)
2943	848	0.38	–0.706	–1.029	1	10Alp CMi (PROCYON)
5056	510	0.98	–0.043	–0.033	1	67Alp Vir (SPICA)
6134	553	0.96	–0.007	–0.023	2	21Alp Sco (ANTARES)
7001	149	0.03	+0.200	+0.285	1	3Alp Lyr (LYRA=VEGA)
3449	452	4.66	–0.103	–0.043	4–3	43Gam Cnc (ASELLI)
15	315	2.06	+0.137	–0.158	2–3	21Alp And (ALPHERATZ)
21	189	2.27	+0.526	–0.177	3	11Bet Cas (CAPH)
188	733	2.04	+0.232	+0.036	3	16Bet Cet (DENEDKAITOS=DIPHDA)
337	346	2.06	+0.179	–0.109	3	43Bet And (MIRACH)
617	375	2.00	+0.190	–0.144	3–2	13Alp Ari (HAMAL)
1231	781	2.95	+0.057	–0.110	3	34Gam Eri (ZAURAK)
1457	393	0.85	+0.065	–0.189	1	87Alp Tau (ALDEBARAN)
1791	400	1.65	+0.025	–0.175	3	112Bet Tau (ELNATH)
2491	818	–1.46	–0.545	–1.211	1	9Alp CMa (SIRIUS)
2890	424	1.58	–0.170	–0.102	2	66Alp Gem (CASTOR)
2990	425	1.14	–0.627	–0.051	2	78Bet Gem (POLLUX)
4057	467	2.61	+0.307	–0.151	2	41Gam1 Leo (ALGIEBA)
4301	24	1.79	–0.118	–0.071	2	50Alp UMa (DUBHE)
4534	488	2.14	–0.497	–0.119	1–2	94Bet Leo (DENEBOLA)
4660	26	3.31	+0.102	+0.004	3	69Del UMa (NEGREZ)
4905	33	1.77	+0.109	–0.010	2	77Eps UMa (ALIOTH)
4914	36	5.60	–0.238	+0.057	3	12Alp1 CVn (COR CAROLI)
5054	34	2.27	+0.119	–0.025	2	79Zet UMa (MIZAR)
5191	35	1.86	–0.124	–0.014	2	85Eta UMa (ALKAID)
5267	970	0.61	–0.020	–0.023	2	Bet Cen (AGENA)
5793	111	2.23	+0.120	–0.091	2–1	5Alp CrB (ALPHEKKA)
5854	271	2.65	+0.136	+0.044	3	24Alp Ser (UNUKALHAI)
6556	234	2.08	+0.117	–0.227	3–2	55Alp Oph (RASALHAGUE)
6879	572	1.85	–0.032	–0.125	3	20Eps Sgr (KAUS AUSTRALIS)
7557	288	0.77	+0.537	+0.387	2–1	53Alp Aql (ALTAIR)
7602	287	3.71	+0.048	–0.482	3	60Bet Aql (ALSHAIM)
8162	78	2.44	+0.150	+0.052	3	5Alp Cep (ALDERAMIN)
8728	1011	1.16	+0.336	–0.161	1	24Alp PsA (FOMALHAUT)
8775	317	2.42	+0.188	+0.142	2–3	53Bet Peg (SCHEAT)

Table 7.3. A list of fast stars possessing old names of their own according to BS4 ([1197]), all transcribed in capital letters as the most famous stars in the Middle Ages. All the celestial areas are represented here. The list is preceded by the 8 stars from the informative kernel of the Almagest, some of which don't rank among the fast stars.

Almagest. The error was calculated after the compensation of the systematic error $\gamma = 20'$. We observe fluctuations within a more or less constant value range for the entire time interval under study. A 10-minute latitudinal range covers 3-13 stars in various years, whereas about 11-16 stars wind up within the 20-minute range. These graphs give us no reliable information concerning the most probable dating of the catalogue.

In fig. 7.8 we cite the mean-average discrepancy dependency graph similar to the graph in fig. 7.5. However, the only stars we took into consideration this time were the ones that got a latitudinal discrepancy of less than 30 minutes for a given dating. One sees the graph to consist of gently sloping parabola segments whose minimums fall on different years on the time axis. Thus, various parts of the 37-star list contain the valleys of respective parabolas scattered all across the historical interval.

The discovered instability of the valleys tells us that this dating method is a very imprecise one due to the fact that the valleys of many parabolas are situated at a considerable distance from the catalogue compilation date. Therefore, a variation of the stellar contingent shall distribute these valleys chaotically over the entire length of the historical interval.

In general, the graph in fig. 7.8 has its extremely poorly-manifest valley fall on the period of 700-1600 A.D., which is of zero use for a reliable dating.

We have also considered other possibilities of expanding the Almagest's informative kernel – for instance, using stellar luminosity as a criterium. Nearly all of them led to a drastic decrease in stellar coordinate precision and what can be de facto regarded as eliminating of dependency between the dating of the observations and the extended list characteristics. However, it turns out that the informative error does in fact allow a natural expansion without a drastic precision decrease. This issue is considered in detail below.

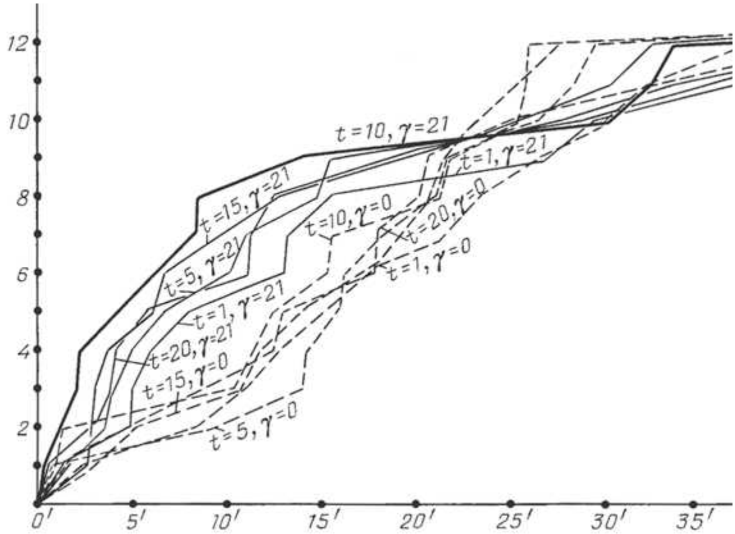


Fig. 7.4. Empirical distribution functions for the 13 bright named Almagest stars with t = 1, 5, 10, 15 and 20. Continuous lines: $\gamma = 21'$; dotted lines: $\gamma = 0$.

3.
THE STATISTICAL DATING PROCEDURE

3.1.The description of the dating procedure

The hypothesis about the named stars of the Almagest measured in correspondence with the aberration rate of 10 minutes allows us to give a rather approximate real dating of the Almagest in section 2. We proved that the configuration of the Almagest catalogue informative kernel varies over the course of time at a high enough speed for us to determine the catalogue compilation date. Therefore one finds it makes sense to set the problem of estimating the possible dating interval.

The following procedure that we shall refer to as statistical appears to be of the most natural and obvious character; it is based on the hypothesis that the named Almagest stars were measured with a declared 10-minute latitudinal precision. Furthermore, we shall base our research on the statistic characteristics of group errors as rendered in Chapter 6. The statistical dating procedure is as follows:

A) Let us specify the confidence level $1 - \varepsilon$.

B) Now we shall consider time moment t and trust

interval $I_\gamma(\varepsilon)$ for the compound $\gamma_{stat}^{ZodA}(t)$ of the group error in area *Zod A*. Now to estimate the value

$$\Delta(t) = \min \Delta(t, \gamma, \varphi), \qquad (7.3.1)$$

where the minimum is taken for all γ in $I_\gamma(\varepsilon)$ with varying φ values, while the value of

$$\Delta(t, \gamma, \varphi) = \max_{1 \le i \le 8} |\Delta B_i(t, \gamma, \varphi)|$$

defines the maximal discrepancy for all the stars from the informative kernel as calculated for the presumed dating *t*. Parameters (γ, φ) define a certain turn of a celestial sphere – quite arbitrarily so, as a matter of fact, qv in fig. 3.14.

C) If the educed value of $\Delta(t)$ does not exceed the declared catalogue precision rate of 10', time moment *t* should be regarded as the possible catalogue compilation date. Otherwise the catalogue cannot be dated to epoch *t*.

Quite obviously, the result of applying this dating procedure depends on the subjective choice of trust level $1 - \varepsilon$. Therefore its stability shall have to be tested against the variations of ε, which is carried out below.

3.2. The dependency of the minimax discrepancy Δ on *t*, γ and φ for the Almagest

We shall draw a graph for 8 of the named Almagest stars comprising the informative kernel to represent the dependency of the minimax latitudinal discrepancy $\Delta(t, \gamma, \varphi)$ on all three variables. This dependency is shown as a sequence of diagrams in figs. 7.9 and 7.10. Every diagram here corresponds to some fixed moment *t*. The diagrams are given for $t = 1, \dots, 18$. For other *t* values the respective diagrams prove void, as is the case with $t = 1$. Let us remind the reader that $t = 1$ corresponds to 1800 A.D., and $t = 18$ – to the beginning of the new era. The horizontal axes of the diagrams bear the values of γ, and the vertical – the values of φ.

Double shading marks the areas for which $\Delta(t, \gamma, \varphi) \le 10'$.

Shaded areas correspond to $10' < \Delta(t, \gamma, \varphi) \le 15'$.

The area filled with dots corresponds to $15' < \Delta(t, \gamma, \varphi) \le 20'$.

For the rest of the drawings, the expression $\Delta(t, \gamma, \varphi) > 20'$ is true. On every drawing the parameters $\gamma_{stat}^{ZodA}(t)$, $\varphi_{stat}^{ZodA}(t)$ are marked by a large dot.

The diagrams demonstrate that the "spot" with double shading that corresponds to the maximal latitudinal discrepancy of 10' for the eight named Almagest stars only exists for time moments falling into the range of $6 \le t \le 13$, or the interval between 600 and 1300 A.D.

The area with normal shading that corresponds to the maximal latitudinal discrepancy of 15' only exists for $4 \le t \le 16$. Maximal sizes of these areas are reached at $7 \le t \le 12$. For $t > 18$ the acceptable interval alteration area defined by correspondent confidence intervals contains no points where $\Delta(t, \gamma, \varphi) < 20'$. In particular, this is true for the Scaligerian dating of the epochs when Ptolemy and Hipparchus lived. Furthermore, when we attempt to date the Almagest catalogue to 100 A.D. or an earlier epoch, the latitudinal discrepancy minimax $\Delta(t)$ turns out to be two times greater than the declared 10-minute precision of the Almagest catalogue. For datings preceding 100 A.D. the value of $\Delta(t)$ exceeds even the mean-average residual error for the stars from areas *A, Zod A, B* and *Zod B*, being close to the square average residual Almagest error for celestial area *M*, or rather dim stars of the Milky Way (where the observations of such stars were complicated by the abundant stellar background which would impair their precision making its rate unacceptably low for the bright named stars). One therefore has to reject the dating of the Almagest to the epoch of roughly 100 A.D. or earlier as contradicting the Almagest catalogue.

Thus, figs. 7.9 and 7.10 demonstrate that the area permitted by the values of γ and φ fundamentally gives us no opportunity of making the latitudinal discrepancy of all 8 stars comprising the Almagest's informative kernel less than 10' for epochs preceding 600 A.D. If we are to raise the error rate threshold to 15', the earliest possible dating of the Almagest is 300 A.D.

3.3. Results of dating the Almagest catalogue statistically

Let us assign variation area $S_t(\alpha)$ of parameter γ in the following manner:

$$S_t(\alpha) = \{\gamma : \min_{\varphi} \Delta(t, \gamma, \varphi) \le \alpha\}$$

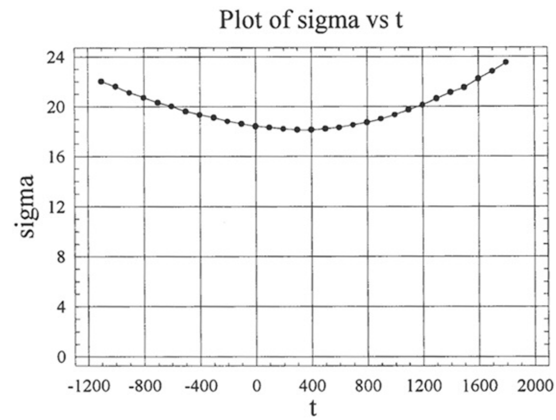


Fig. 7.5. The square average discrepancy for the 37 Almagest stars listed in Table 7.3 as the presumed dating function. The systematic error γ of the Almagest catalogue was compensated in the calculation of the discrepancy. Apart from that, the desired square average discrepancy was minimised in accordance with the variations of $\gamma = \gamma_{stat} \pm 5'$; $\beta = 0 \pm 30'$.

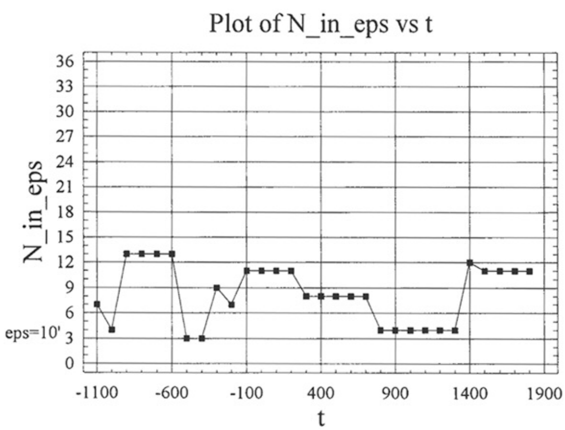


Fig. 7.6. Vertical axis: the number of Almagest stars from the list of 37 (qv in Table 7.3) whose latitudinal discrepancy doesn't exceed 10 minutes. Horizontal axis: presumed dating of the Almagest catalogue.

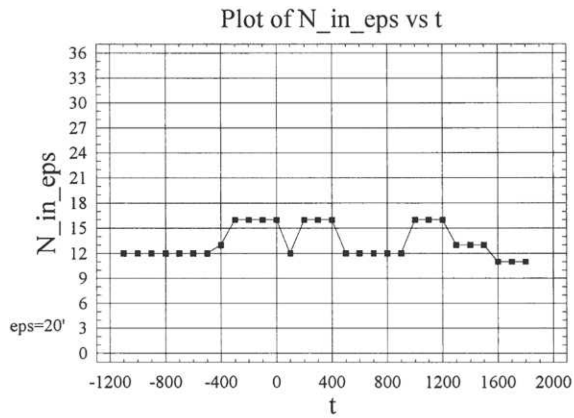


Fig. 7.7. Vertical axis: number of Almagest stars from the list of 37 (qv in Table 7.3) whose latitudinal discrepancy doesn't exceed 20'. Horizontal axis: presumed dating of the catalogue.

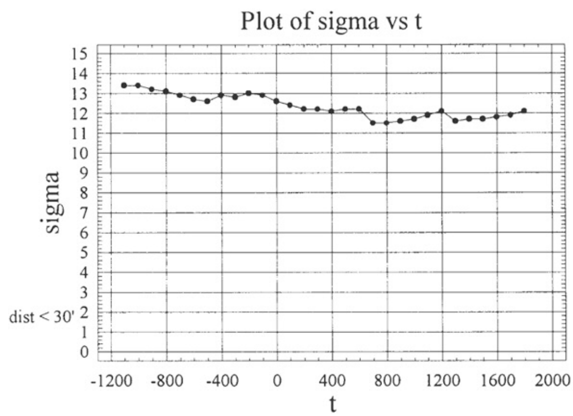


Fig. 7.8. The square average deviation for the 37 Almagest stars listed in Table 7.3, whose latitudinal discrepancy doesn't exceed 30 minutes for the presumed dating in question. The graph is built as a function of the presumed Almagest dating. In the search of the discrepancy, the catalogue's systematic error γ was compensated. Apart from that, the square average discrepancy was minimised by the variations of $\gamma = \gamma_{stat} \pm 5'$; $\beta = 0 \pm 30'$.

Set $S_t(\alpha)$ may yet turn out empty. Let us consider the intersection of set $S_t(\alpha)$ and the confidence interval $I_\gamma(\varepsilon)$ built around the value of $\gamma_{stat}^{ZodA}(t)$. If this intersection isn't empty, we can declare moment t to be the possible epoch of the Almagest catalogue's compilation in accordance with the statistical dating procedure. All of such moments t taken as a whole can be referred to as the possible dating interval of the Almagest catalogue.

The result of calculating $S_t(\alpha)$ for the Almagest is represented graphically in fig. 7.11. The dots fill the union of sets $S_t(\alpha)$ for α =10'. The surrounding outline corresponds to the value α =15'. We shall find a use for it later.

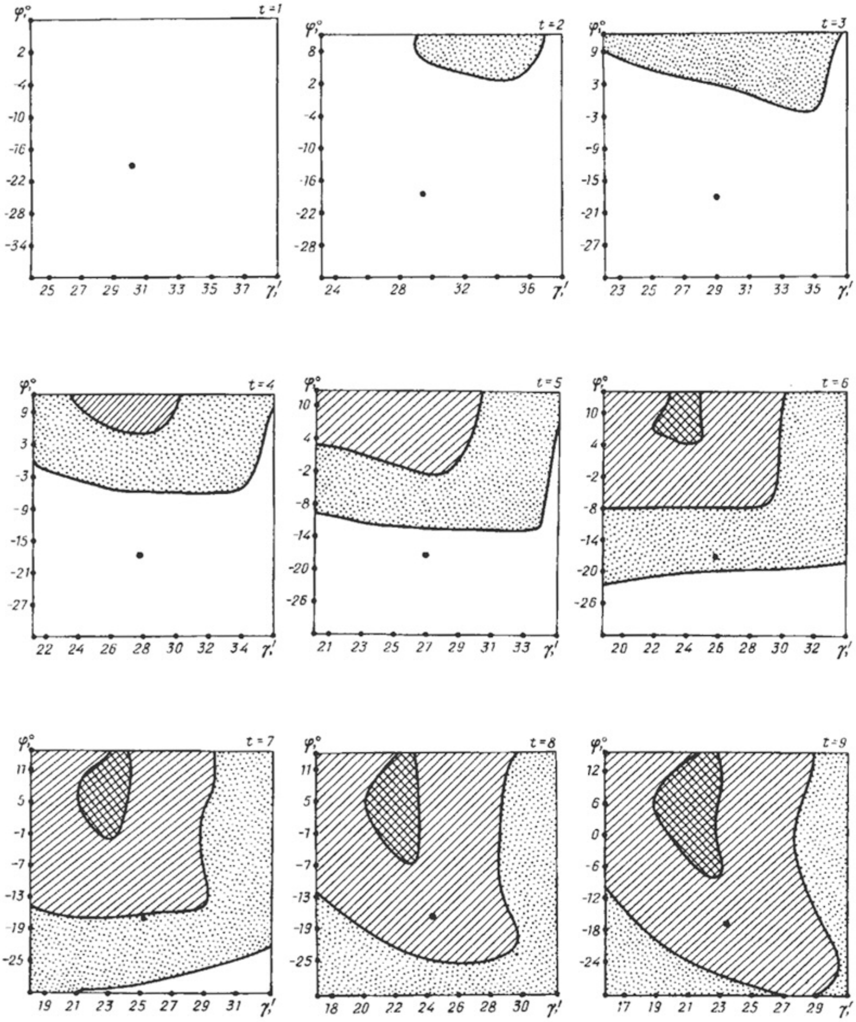


Fig. 7.9. One sees the dependency $\Delta(t, \gamma, \varphi)$ for the time values t beginning with 1, or 1800 A.D., and ending with $t = 18$, or 100 B.C. The area with double shading corresponds to $\Delta \leq 10'$. The area with single shading corresponds to $10' < \Delta \leq 15'$. The area filled with dots corresponds to $15' < \Delta \leq 20'$. The large dot corresponds to parameter pairs of $\gamma_{stat}^{ZodA}(t)$, $\varphi_{stat}^{ZodA}(t)$.

The graph of the function $\gamma_{stat}^{ZodA}(t)$ used herein was calculated in Chapter 6 (see fig. 6.8). The values of trust intervals $I_\gamma(\varepsilon)$ that correspond to different values of ε can be found in table 6.3. Fig. 7.11 implies that the possible dating interval is the same for $\varepsilon = 0.1$, $\varepsilon = 0.05$, $\varepsilon = 0.01$ and $\varepsilon = 0.005$ – namely, $6 \leq t \leq 13$.

If we are to translate the resultant dating result into regular years, we shall see that the possible dating interval in the Almagest catalogue begins in 600 A.D. and ends in 1300 A.D.

3.4. The discussion of the result

The length of the possible catalogue dating interval we ended up with equals 700 years: 1300 – 600 = 700.

The interval is a rather large one for a number of reasons. We already named the first one – the low precision of the Almagest catalogue, even if we are to accept Ptolemy's declared precision of 10'.

Such low precision makes it impossible to date the

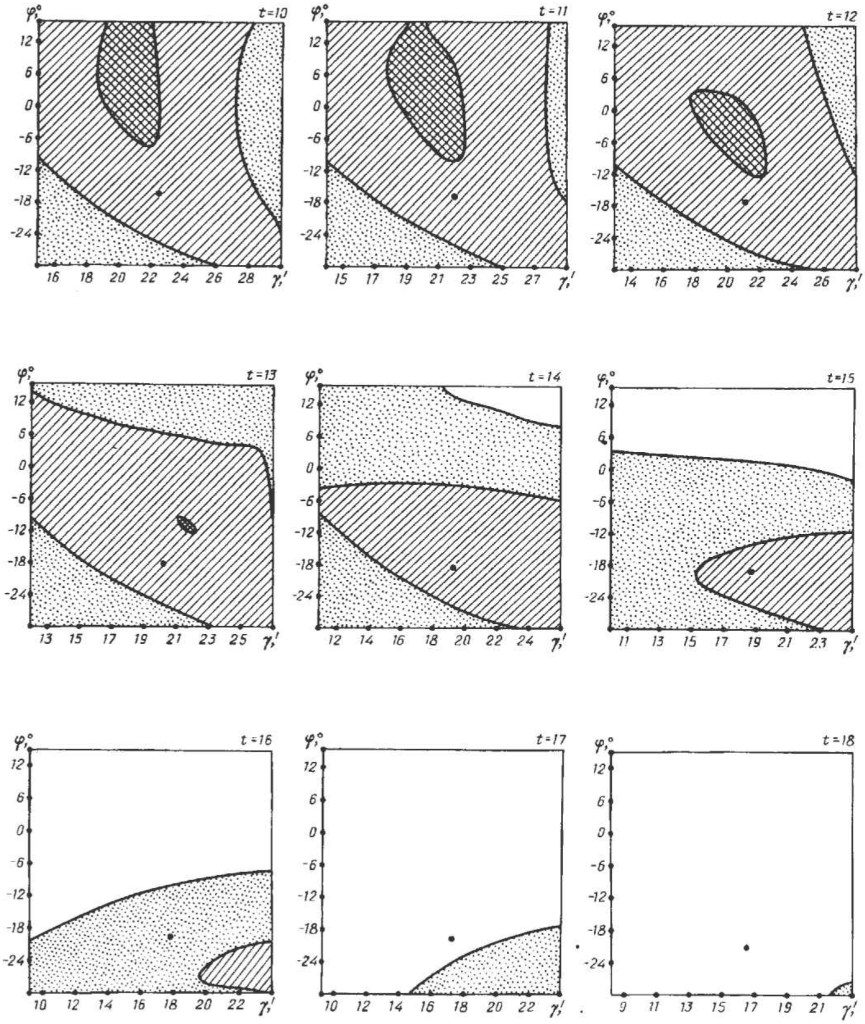


Fig. 7.10. The previous figure continued.

catalogue to a narrower time interval since even the fastest of the named stars under study (Arcturus) alters its latitude by a mere 10' every 260 years.

The value is great, and it is greater still for other kernel stars.

The second reason stems from the fact that we have only used the trust intervals of the group error's γ compound, having minimized the value $\Delta(t, \gamma, \varphi)$ by various possible values of φ, qv in formulae 7.3.1 and 7.3.2.

This approach obviously leads to the broadening of the Almagest catalogue dating interval. Indeed, if we could consider φ to be a group error like γ, we would select parameter φ from the confidence strip. This would raise the value of $\min\limits_{\varphi} \Delta(t, \gamma, \varphi)$ and thus narrow the possible dating interval.

However, as it has been pointed out above, we do not have enough reasons to consider φ a group error in stellar groups from the Almagest that we have studied.

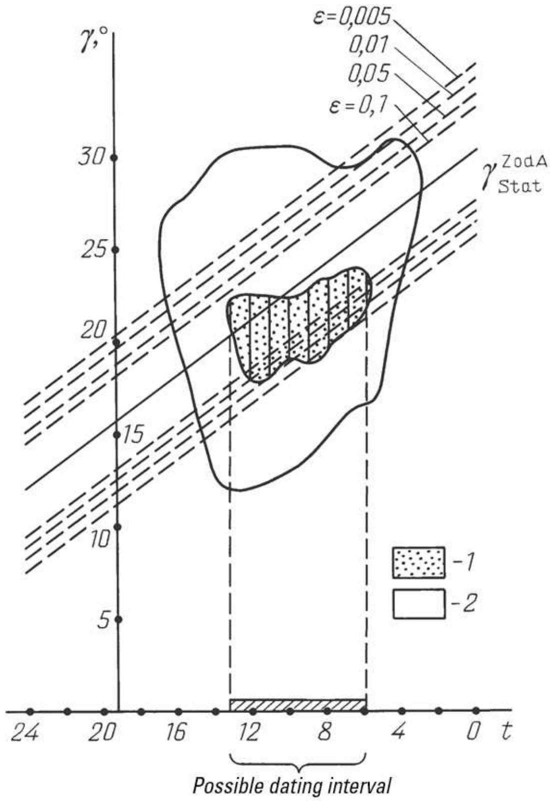


Fig. 7.11. Result of the statistical dating procedure as applied to the Almagest catalogue and using its eight named stars.

4. DATING THE ALMAGEST CATALOGUE BY THE EXPANDED INFORMATIVE KERNEL

The issue of expanding the informative kernel of the Almagest has been discussed above at the end of section 7.2. It was discovered that if we expand the kernel choosing bright and fast stars for this purpose without following any system, we cannot get an informative dating. We already understand that this is explained by the low average precision of Ptolemy's measurements, and this concerns even the bright stars. The question of what principle one could use in order to expand the 8-star informative kernel of the Almagest without the loss of latitudinal precision remains open.

We managed to solve this problem. Let us ponder the exact method used by Ptolemy in order to measure stellar latitude. It is known quite well in history of astronomy that such measurements were conducted with bright basis stars used as a "framework" of sorts which the desired stellar positions would be educed from in all the measurements to follow. The coordinates of these stars would be measured with the utmost precision and used later on. Ptolemy does not specify the exact stars that he used for basis; as we can see from the text of the Almagest, such basis stars have at least been Regulus, Spica, Antares and possibly Aldebaran (see page 247 of [1120], for instance). Three of them – namely, Regulus, Spica and Antares – have names of their own in the Almagest that employ the formula "vocatur ..." ("named ..."), qv above. We formulated the idea that the named stars of the Almagest received names because they served as the basis for Ptolemy's observations in the first place. This idea is confirmed by the fact that, as we have proved, the named stars of the Almagest really possess the Ptolemaic reference precision of 10' (insofar as the latitudes are concerned, at least) in areas *A, Zod A, B* and *Zod B*. This isn't true for the longitudes, but we already mentioned that it is a great deal more difficult to observe the longitudes than the latitudes. Apart from that, longitudinal precision was most probably lost when the Almagest catalogue had been re-calculated in order to correspond to other epochs. Therefore the latitudes cannot serve as a criterion of Ptolemy's real precision. It is only the latitudes that one can rely upon for this purpose.

We could prove none of the above for other celestial areas, since the systematic error rates could not be established reliably. Therefore we shall refrain from going beyond celestial areas *A, Zod A, B* and *Zod B* in our search for possible informative kernel extensions.

Let us ask about what other stars except for the basis ones – the "top ranking" stars, that is, would also be measured very well by Ptolemy? Quite naturally, the ones located in the immediate vicinity of the basis stars – the primary reason being that Ptolemy's coordinates are most likely to have followed "links" of sorts, when the coordinates of the stars close to the basis ones would be measured first, and he would proceed further taking the previously-calculated coordinates into account, step by step. Nowadays we understand that this measurement method inevitably leads to ran-

dom error dispersion growth, which means greater coordinate measurement errors. The further a star is from the referential kernel, the worse it shall be measured on the average.

It would thus make sense to attempt an extension of the informative kernel, adding the stars "ranking second" thereto, which are bright enough, well-identified and located in close proximity to the basis stars. One would then have to proceed with the "third rank" of stars which are further away, the "fourth rank" which is even further and so on. If we notice this process to be accompanied by a slow decrease in average latitude precision remaining virtually the same for the basis stars and the ones closest to them, we shall ipso facto confirm our presumption that the "top ranking" stars were really included into the basis referential framework. We shall also get the opportunity to extend the "dating kernel" of the catalogue as well as checking (and, possibly, correcting) our dating.

This idea was implemented in the following manner. First of all we would have to use nothing but the stars which have perfectly sound and dependable Almagest identifications as well as observable proper movement. They are listed in table 4.3. There are 68 such stars altogether. Bear in mind that the 8-star informative kernel is included in this list in its entirety.

Eight information kernel stars were taken to represent the "top level". We have calculated the latitudinal mean-square aberration for all of them after the compensation of the systematic error. Systematic error γ was calculated in Chapter 6. We allowed for a fluctuation of this error's value within the range of ±5' with a 1-minute step. Parameter β would define the excesses within the limits of ±20' with the same step value. The mean-average discrepancy for each presumed dating of the catalogue would be selected as the minimal value achieved by said variations of parameters γ and β. The result is presented as the dependency graph of the square average discrepancy of the presumed Almagest catalogue dating. The graph built for eight of the informative kernel stars, or "top level" stars, can be seen in fig. 7.12.

The graph's minimum is reached around 900-1000 A.D. at the level of 5-6 arc minutes. This means that the guaranteed latitudinal measurement precision for Ptolemy equalled 10'-15'. Indeed, all the stars of the informative kernel are measured with the precision

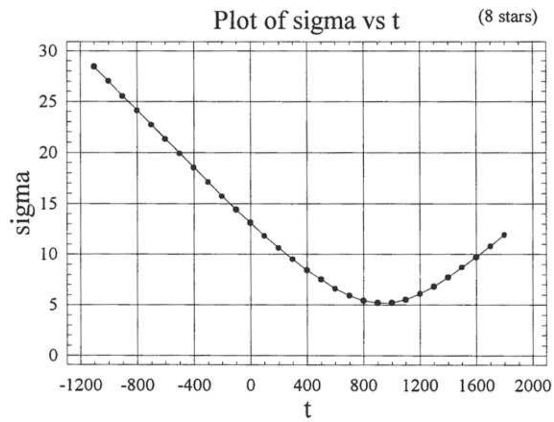


Fig. 7.12. Square average latitudinal discrepancy graph after the compensation of the systematic error for the eight "first level" stars. These eight stars comprise the informative kernel of the Almagest catalogue. According to our calculations, these very stars served as reference points in Ptolemy's observations. The square average discrepancy was minimised in accordance with the variations of parameter γ for the interval of γ_{stat} ± 5', and the variations of parameter β for the interval of 0 ± 20'. The graph reaches its minimum in 900-1000 A.D., at the level of 5-6 arc minutes. The discrepancy equals 12' for the Ptolemaic epoch of the II century A.D., which exceeds the minimum by a factor of two. The discrepancy for the epoch of Hipparchus (the II century B.C.) approximately equals 14'.

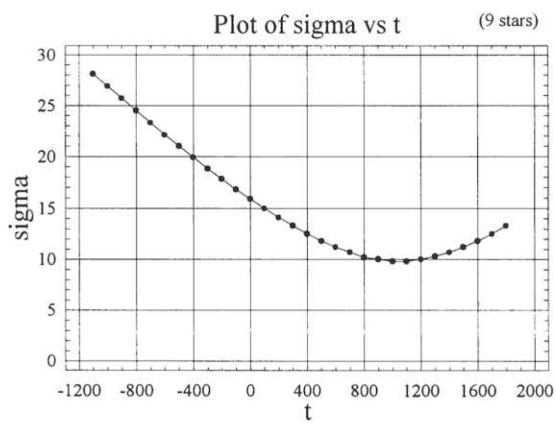


Fig. 7.13. Square average latitudinal discrepancy graph after the compensation of the systematic error for the nine "second level" stars located at the maximal distance of 5 degrees for the base ones. The square average discrepancy was minimised in accordance with the variations of parameter γ for the interval of γ_{stat} ± 5', and the variations of parameter β for the interval of 0 ± 20'. The graph reaches its minimum in 1000-1100 A.D., at the level of 9-10 arc minutes. The square average discrepancy equals 15' at least for the epoch of II century A.D. and the ones preceding it.

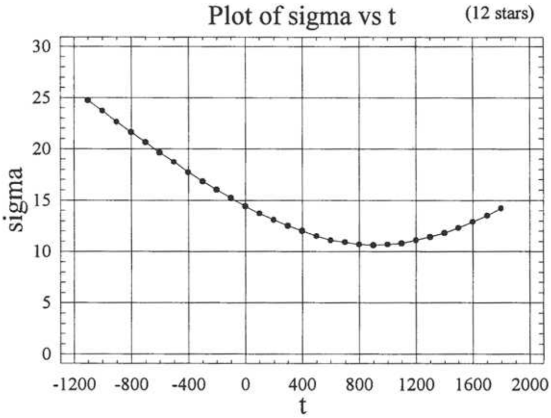


Fig. 7.14. Square average latitudinal discrepancy graph after the compensation of the systematic error for the twelve "third level" stars located at the maximal distance of 10 degrees for the base ones. The square average discrepancy was minimised in accordance with the variations of parameter γ for the interval of $\gamma_{stat} \pm 5'$, and the variations of parameter β for the interval of $0 \pm 20'$. The graph reaches its minimum in 900 A.D., at the level of 11'. The discrepancy equals 14' and more for the epoch of 100 A.D. and the ones preceding it.

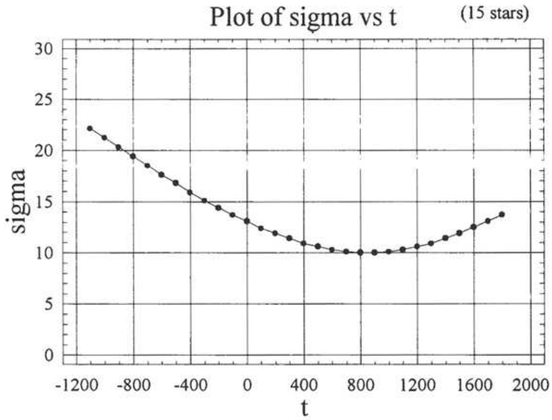


Fig. 7.15. Square average latitudinal discrepancy graph after the compensation of the systematic error for the fifteen "fourth level" stars located at the maximal distance of 15 degrees for the base ones. The square average discrepancy was minimised in accordance with the variations of parameter γ for the interval of $\gamma_{stat} \pm 5'$, and the variations of parameter β for the interval of $0 \pm 20'$. The graph reaches its minimum in 800-900 A.D., at the level of 10-11'. The discrepancy equals 12' for the epoch of 100 A.D.

of 10' or better, as we have already observed. This is in perfect concurrence with the scale grade value chosen by Ptolemy – 10'.

As for the epoch of the II century A.D., the discrepancy here reaches 12'. This is two times the permissible minimal value, which makes the early A.D. epoch completely unacceptable for the Almagest catalogue, let alone the "epoch of Hipparchus" that is supposed to have preceded it, for the discrepancy equals circa 14' for the II century B.C.

All the stars from table 4.3 were taken as the "second level" stars which are at no further distance from the closest informative kernel star than 5 degrees. There proved to be 9 such stars including the informative kernel. It turned out that we needed to add star 47δ Cnc (#3461 in catalogues BS4 and BS5). The resultant square average discrepancy graph can be seen in fig. 7.13. It is plainly visible that the picture drastically changes once we add a single star to the eight that comprise the informative kernel – and it is just one, which is close to them, well-visible to the naked eye, and isolated to boot. The reason is most likely to be that the named stars were used by Ptolemy for reference and thus were measured several times with the utmost precision. The rest of them must have been measured "following a link" from a referential star.

Nevertheless, the graph we encounter in fig. 7.13 is still informative enough. The discrepancy graph's minimum is reached around 1000-1100 A.D. at the level of 9-10 arc minutes. The square average discrepancy is substantially greater for the epoch of the II century A.D. as well as the ones preceding it. It equals 15' for 100 A.D., which is substantially greater than 150% of the minimal value.

The "third level" stars are all the stars from table 4.3 that are located at the maximal distance of 10 degrees from the informative kernel. We discovered there to be 12 such stars including the informative kernel. Apart from 47δ Cnc, the informative kernel was expanded to include 14o Leo (#3852), 8η Boo (#5235) and 26ε Sco (#6241).

The discrepancy graph is demonstrated in fig. 7.14. It hardly differs from what we had in the previous step at all. This is well understood. We are still very close to the informative kernel, which still comprises ¾ of the total amount of stars in the sample. The graph's min-

imum is reached in 900 A.D. or at the level of 11'. The discrepancy for the epoch of 100 A.D. and earlier the discrepancy equals 14' or more. Judging by fig. 7.14, the most possible dating of the Almagest catalogue is the interval between the alleged years 400 and 1400 A.D.

We have taken all the "fourth level" stars from table 4.3 – the ones located at the maximum distance of 15 degrees from the informative kernel. There are 15 such stars, new additions being 78β Gem (2990), 79ζ Vir (#5107) and 24μ Leo (#3905). The discrepancy graph can be seen in fig. 7.15. The graph's minimum is reached around 800-900 A.D. at the level of 10'-11'. The discrepancy equals 12' for the epoch of 100 A.D. Thus, the value of the minimal square average discrepancy hardly alters at all. Apparently, for distances under 15° Ptolemy's tools would still allow to measure stellar coordinates against the actual basis stars, and not "following links".

Finally, for "fifth level" stars we took the ones included in Table 4.3, located at the maximal distance of 20 degrees from the informative kernel. There are 22 such stars including the informative kernel – the newcomers are 112β Tau (#1791), 60ι Gem (#2821), 68δ Leo (#4357), 29γ Boo (#5435), 3β CrB (#5747) and 5α CrB (#5793).

The discrepancy graph is shown in fig. 7.16. The graph's minimum is reached around 400-800 A.D. at the level of 22'-23'. This is the mean-square error level which is characteristic for the Almagest catalogue in general, which is to say that the effect of the basis star proximity ceases to manifest at distances of 15°-20°. The graph became almost even due to a visible decrease in measurement precision at such a distance from the basis stars. The discrepancy equals 23' for the beginning of the new era, 24' for the epoch of the V century B.C., and so on.

The last step demonstrates a drastic drop in measurement precision. The square average error rate grew by a factor of two. Therefore, before we move on in our extension of the catalogue's informative kernel, let us agree to count the square average discrepancy using only those stars for reference who get a maximal latitudinal error of 30 minutes for the assumed dating of the Almagest catalogue. This shall allow us to exclude the star which Ptolemy measured the worst from the very beginning. The choice of such stars naturally depends on the alleged dating of the catalogue. Certain

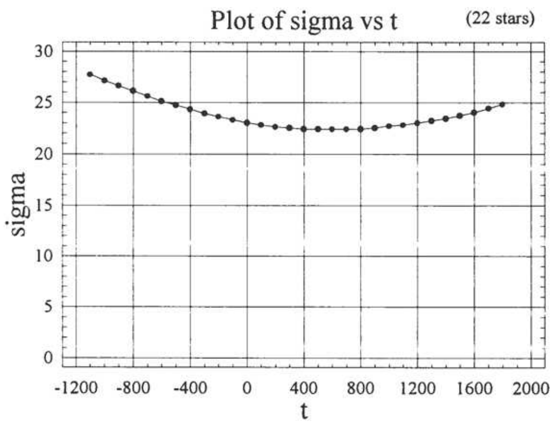


Fig. 7.16. Square average latitudinal discrepancy graph after the compensation of the systematic error for the twenty-two "fifth level" stars located at the maximal distance of 20 degrees for the base ones. The square average discrepancy was minimised in accordance with the variations of parameter γ for the interval of $\gamma_{stat} \pm 5'$, and the variations of parameter β for the interval of 0 ± 20'. The graph reaches its minimum in 400-800 A.D., at the level of 22-23'. This is the level that we find to be characteristic for the Almagest catalogue in general. In other words, the proximity of the "base stars" ceases to be effective at the distance of some 15-20 degrees. The graph became almost even due to the significantly lowered precision of calculations at such distance from the base stars. The discrepancy equals 23' for the beginning of the new era, 24' for the epoch of the V century B.C. etc.

alleged datings might make one star look measured well and another poorly, and vice versa.

We shall continue with compensating the systematic error discovered in the Almagest catalogue and make γ as well as β fluctuate within the same range as above.

The amount of stars that we find in the sample after such a selection shall be represented on the same drawing as the discrepancy. The resulting picture can be seen in fig. 7.17. One sees that the minimal square average discrepancy drops to 9' once again for 800-900 B.C., whereas the Scaligerian epoch of Ptolemy and Hipparchus, or 400 B.C. – 100 A.D., makes the discrepancy values maximal, reaching up to 12'. Let us point out that the resultant discrepancy values of 9' for the presumed dating period of 800-900 A.D. correlate very well with the discrepancy limit of 30' as specified beforehand. The matter is that the normally-distributed

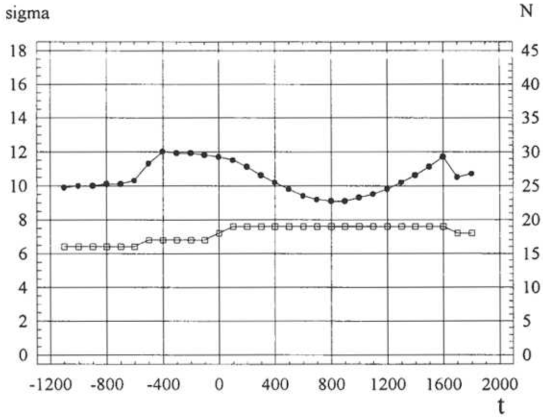


Fig. 7.17. Square average latitudinal discrepancy graph for the collected stars from table 4.3 located within 20 degrees from the stars of the catalogue's informative kernel. One can also see the graph for the number of stars in this group. The stars whose latitudinal discrepancy exceeded 30 minutes for the presumed dating in question were excluded from the sample. The systematic error of the catalogue was compensated.

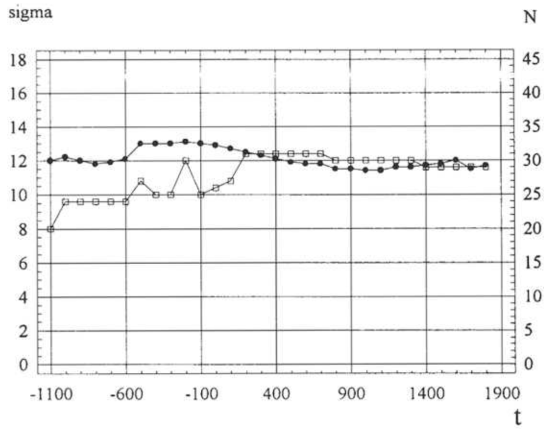


Fig. 7.19. A similar square average latitudinal discrepancy graph for the group of stars from table 4.3 located within 30 degrees from the stars of the catalogue's informative kernel. We also presented a graph for the number of stars in the group.

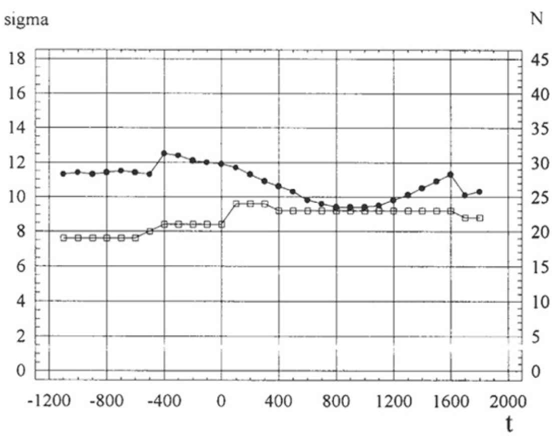


Fig. 7.18. A similar square average latitudinal discrepancy graph for the group of stars from table 4.3 located within 25 degrees from the stars of the catalogue's informative kernel. We also presented a graph for the number of stars in the group.

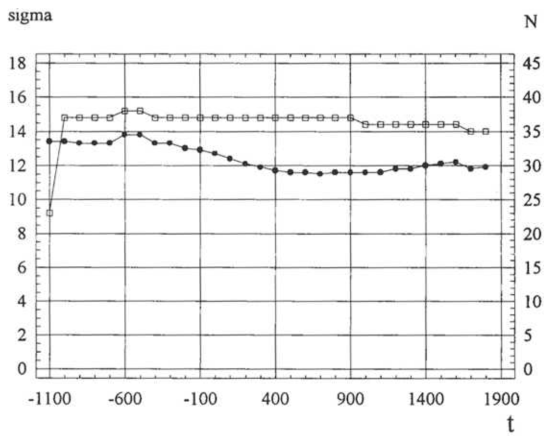


Fig. 7.20. A similar square average latitudinal discrepancy graph for the group of stars from table 4.3 located within 35 degrees from the stars of the catalogue's informative kernel. We also presented a graph for the number of stars in the group.

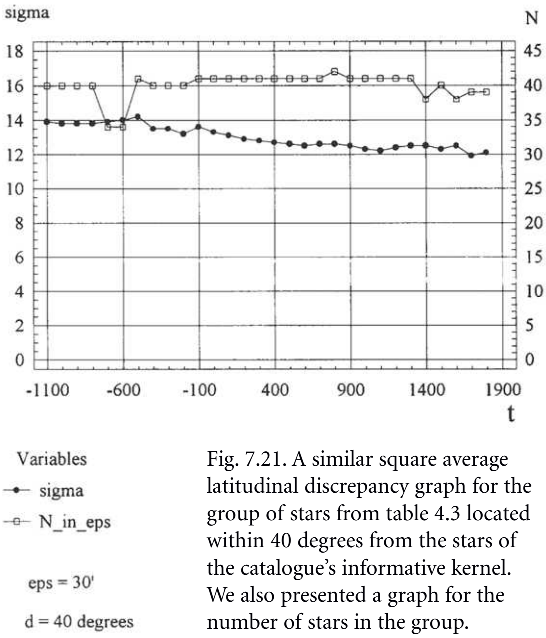


Fig. 7.21. A similar square average latitudinal discrepancy graph for the group of stars from table 4.3 located within 40 degrees from the stars of the catalogue's informative kernel. We also presented a graph for the number of stars in the group.

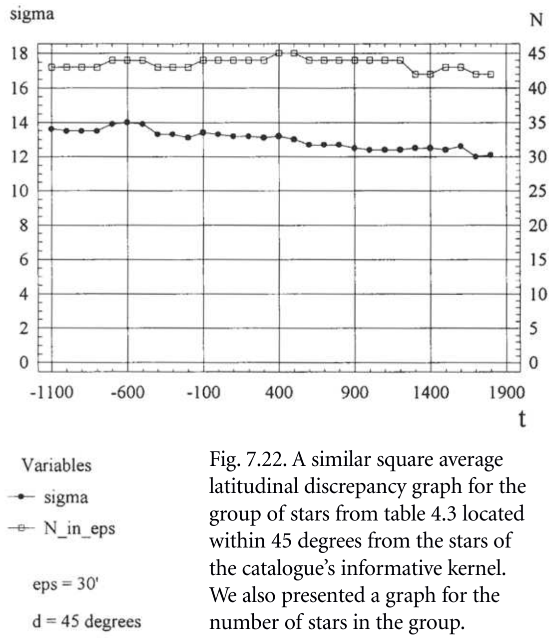


Fig. 7.22. A similar square average latitudinal discrepancy graph for the group of stars from table 4.3 located within 45 degrees from the stars of the catalogue's informative kernel. We also presented a graph for the number of stars in the group.

random value with the square average discrepancy of circa 9'-10' is likely to remain within the limits of 30' or 3σ, the probability rate being close to 1.

Let us now expand the maximal distance between the stars and the catalogue's informative kernel from 20° to 25°. We shall still only regard the stars whose latitudinal error does not exceed 30' for the presumed dating in question. See the resulting graphs in fig. 7.18 representing the discrepancy as well as the amount of stars included in the sample for each presumed dating. The square average discrepancy minimum is reached on the interval between 800 and 1000 A.D., equaling circa 9.5'. The maximal discrepancy rate is roughly equivalent to 12.5' and is reached around 400 B.C. The Scaligerian epoch of Ptolemy and Hipparchus, or the beginning of the new era, has a discrepancy rate approximating the maximum – about 12'. The amount of stars in the sample varies from 21 to 24. There are 23 stars in the sample corresponding to the minimal square average discrepancy.

We shall proceed to raise the acceptable distance between the stars and the kernel from 25° to 30°, keeping all other parameters just the same as they were. The result can be seen in fig. 7.19. Once again, the minimal possible latitudinal discrepancy can only be reached after 800 A.D. This sample contains 30 stars. The amount of stars in the sample varies between 20 and 31 stars for different presumed datings. Around the beginning of the new era the discrepancy rate is roughly equivalent to 13', which is close to the maximal value for the graph in question.

In figs. 7.20, 7.21 and 7.22 one finds similar graphs for the stars whose distance from the Almagest catalogue kernel does not exceed 35°, 40° and 45°, respectively. The sample consists of roughly 40 stars. The latitudinal square average discrepancy minimum becomes less manifest and "drifts towards the future". The graph in general begins to look more and more horizontal.

Corollary. Thus, the Almagest catalogue can be dated by the proper movement of a configuration of roughly 20 stars. The most possible dating interval falls on the same epoch as above, namely, 600-1200 A.D. We also discover that one has to use reliably identifiable stars which aren't located at too great a distance from the informative kernel (20°-25° maximum). If we are to exclude the stars who get a maximal 30-minute latitudinal discrepancy for alleged dating *t* from the sample, we shall end up with about 20 stars. This provides for a graph with a well-manifest minimum as

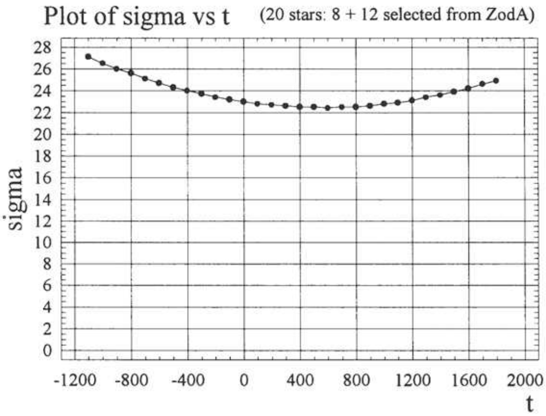


Fig. 7.23. Square average latitudinal discrepancy graph for 20 stars: 12 stars from table 4.3 located in celestial area *Zod A*, excluding the informative kernel stars, and 8 stars of the informative kernel. As one sees from the graph, the latitudinal precision for this list is substantially lower than that for the area *Zod A* on the average.

seen in fig. 7.18. The latitudinal discrepancy minimum of 9' is reached on the interval of 800-1000 A.D. The interval of 600-1200 A.D. corresponds to a discrepancy rate very close to the minimal, one of 9'-9.5'. The epoch of 400 B.C. – 100 A.D. corresponds to the maximal discrepancy rate of 11.5'-12'.

Let us emphasize that the minimal discrepancy of circa 10' can only be reached for a group of several dozen stars on the condition of their proximity to the informative kernel of the Almagest. All the other methods of selecting the stars from the combined areas *A, Zod A, B, Zod B* and *M* – by luminosity, "fame" etc leave us with the discrepancy minimum of roughly 20', which is typical for the Almagest in general. Remaining within a single well-measured area (*Zod A*) is also a non-option. For example, let us regard all the visibly mobile stars from this area as a whole, that is, all the stars from table 4.3 that pertain to celestial area *Zod A*. There are 12 such stars if we don't consider the informative kernel; adding the 8 stars that comprise the latter to this amount shall give us a total of 20 stars. Unfortunately, the latitude precision for this list is rather low – a great deal lower than that of area *Zod A* in general. The corresponding square average latitudinal discrepancy graph for these 20 stars as a function of the Almagest catalogue's presumed dating can be seen in fig. 7.23. The poorly-manifest minimum corresponds to the level of 23'. It is reached on the interval between 400 and 800 A.D. A mere 1' above the minimum, and we shall cover the entire interval of 400 B.C. and 1500 A.D. Therefore, this list doesn't permit any reliable datings due to the low average precision of the stellar latitudes that it contains. Even the eight informative kernel stars cannot improve the average latitudinal precision of this list owing to the fact that most of the visibly mobile stars from area *Zod A* are rather dim, and were therefore measured rather badly by Ptolemy on the average. Bear in mind that the average precision of his latitudinal measurements equals 12'-13' for the entire *Zod A* area, which is a lot better than the 23' that we get for the 20 stars in question.

We have thus managed to expand the informative kernel of the Almagest without any substantial precision losses to 15 reliably and unambiguously identifiable Almagest stars that are also visibly mobile, by which we mean that their minimal annual proper movement speed equals 0.1" by one of the coordinates at least. The choice of the celestial coordinate system is of little importance here, and so we are using the 1900 A.D. equatorial coordinates for the sake of convenience, since they are used in the modern star catalogues that we have used. Let us now cite the final list of the 15 stars that enable a proper movement dating of the Almagest. The BS4 number of the star is specified in parentheses ([1197]).

1) 16α Boo (5340); 2) 13α Aur (1708); 3) 32α Leo (3982); 4) 10α CMi (2943); 5) 67α Vir (5056); 6) 21α Sco (6134); 7) 3α Lyr (7001); 8) 43γ Cnc (3449); 9) 78β Gem (2990); 10) 47δ Cnc (3461); 11) 14o Leo (3852); 12) 24μ Leo (3905); 13) 79ζ Vir (5107); 14) 8η Boo (5235); 15) 26ε Sco (6241).

5. DATING THE ALMAGEST CATALOGUE BY A VARIETY OF 8-STAR CONFIGURATIONS CONSISTING OF BRIGHT STARS

The idea behind this calculation as well as the calculation itself are credited to Professor Dennis Duke from the State University of Florida, an eminent specialist in data analysis. He suggested to study all possible configurations of eight named Almagest stars.

Professor Duke chose a set of 72 stars whose Almagest magnitude is less than 3 (bear in mind that the lower the value, the brighter the star) for this purpose. Then he selected all the 8-star combinations from this number whose maximal latitudinal error in the Almagest catalogue does not exceed 10' for a certain non-zero time interval (t_1, t_2) that covers the entire period between 400 B.C. and 1600 A.D. The total amounted to 736 eight-star combinations out of 500.000 possibilities. Each one of these combinations specifies a dating interval (t_1, t_2) of its own. Professor Duke studied the set of such "dating interval centres", or the set of values $(t_1 + t_2) / 2$. It turns out that if one is to build a frequency distribution histogram of these centres on the time axis, one sees a manifest maximum on the interval of 600-900 A.D., qv in fig. 7.24. Therefore, the epoch of the VII-X century A.D. is the most likely date when the Almagest catalogue was compiled.

The approach suggested by Professor Duke has the advantage that poorly-measured or excessively slow stellar configurations are automatically excluded from the sample due to the fact that their dating intervals are either void for the 10-minute latitudinal threshold, or great enough to go well beyond the historical interval of 400 B.C. – 1500 A.D. as chosen by Professor Duke a priori. It turns out that after such a rigid selection one is still left with a great many configurations, namely, 736 of them, each one containing eight stars. If we are to chose the "dating interval centre" of some such configuration as a dating with a latitudinal level of 10', we shall end up with the Almagest catalogue dating that shall contain some random error, or a perturbed catalogue compilation dating. Once we build a distribution graph of these perturbed datings, we shall be able to date the Almagest catalogue with a great deal more precision than in case of using a single configuration.

The natural assumption is that the true dating of the catalogue equals the average value of the randomly perturbed datings. This average can be estimated by the empirical distribution that we have at our disposal. Considering the true perturbation distribution to be close to normal, it is easy to estimate its dispersion. The selective mean-square distribution aberration as seen in fig. 7.24 roughly equals 350 years. Seeing as how the sample was censored in accordance to an a priori chosen time interval that proved asymmetric in relation to the distribution centre (qv in fig. 7.24), the average estimation for this distribution turns out to be shifted sideways. If we are to take this effect into consideration, the more accurate estimate of the mean-square aberration shall yield an even smaller value.

Moreover, the centre of the selective distribution is located near the year 800. Had the sample elements been independent, one could come to the conclusion that the real dating of the Almagest catalogue compilation can be located within

$$800 \pm (3 \times 400) / \sqrt{736},$$

or 800 ± 45 years. However, one cannot consider the sample elements to be independent since the real precision of the 800 A.D. dating for the Almagest is a great deal lower than ±45 years. Nevertheless, the early A.D. period dating or an even earlier one can be regarded as highly improbable in this situation, and all but out of the question.

6. THE STATISTICAL PROCEDURE OF DATING THE ALMAGEST CATALOGUE: STABILITY ANALYSIS

6.1. The necessity of using variable algorithm values

The implementation of the dating procedure as described above involved a rather arbitrary choice of certain values defining the algorithm, whereas other values result from statistical conclusion. One therefore has to check the behaviour of the resultant dating interval in case of said values being subject to alteration.

6.2. Trust level variation

The value of ε that determines the trust level was chosen rather arbitrarily. Bear in mind that in statistical problems it represents the acceptable error probability rate, that is, $\varepsilon = 0.1$ stands for the error probability rate of 0.1. The smaller the value of ε, the greater the trust interval. The dependency of the trust interval size on ε is studied in chapters 5 and 6 – see table 6.3 in particular.

Let us now consider the variation of our dating in-

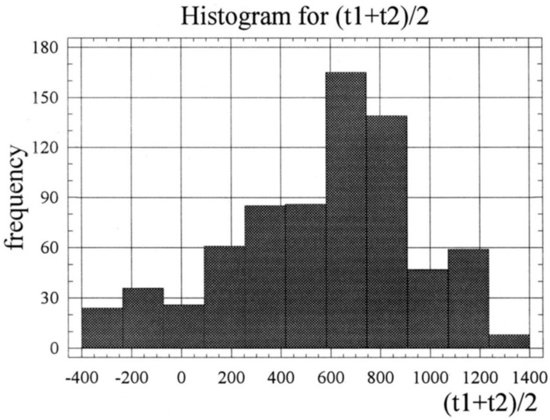


Fig. 7.24. Frequency distribution histogram for the "dating interval" centres of 736 bright Almagest star configurations of 8. One can see the peak manifest at the interval of 600-900 A.D.

terval in accordance with ε. We already mentioned that every value of ε that is less than 0.1 gives us the same dating interval for the Almagest catalogue, and this is also implied by fig. 7.11. This results from the $S_t(\alpha)$interval position where $\alpha = 10'$.

However, let us see whether we should come up with an altogether different picture if we are to choose a different guaranteed precision value α for the Almagest catalogue that will not equal 10 minutes as declared by Ptolemy. Let us consider α to equal 15' (see the corresponding shaded area in fig. 7.11). The possible dating interval of the Almagest catalogue shall naturally expand. The upper threshold of the expanded interval does not depend on ε and equals $t = 3$, or 1600 A.D. The lower threshold is only marginally dependent on ε, namely, it equals $t = 16.3$ for $\varepsilon = 0$, or 270 A.D., whereas $\varepsilon = 0.005$ shall yield $t = 16.5$ – 250 B.C., in other words.

These results therefore demonstrate that the subjective choice of trust level ε hardly affects the value of the lower threshold of the Almagest catalogue's possible dating interval.

We have also discovered how the size of the dating interval is affected by the value of α whose meaning represents the latitudinal measurement precision of the catalogue's named stars – in particular, even raising the value from the precision rate of 10' as declared by Ptolemy to 15', or making it greater by a factor of 1.5, the resultant dating interval of the Almagest catalogue does not include the Scaligerian epoch of Ptolemy, let alone Hipparchus.

6.3. Reducing the contingent of the Almagest catalogue informative kernel

The choice of the catalogue's informative kernel is also subjective to a great extent. Indeed, we have discarded 4 named stars out of 12 – Canopus, Previndemiatrix, Sirius and Aquila = Altair. If the rejection of the first two stars is explained by reasons which are of an extraneous nature insofar as our research is concerned, Sirius and Aquila were rejected due to the fact that the group errors for their respective surroundings fail to coincide with the group error for *Zod A*. However, in Chapter 6 we demonstrate that there are at least two more stars – namely, Lyra and Capella, for which the group errors of their surroundings fail to correspond with the group error for *Zod A*. The previous presumption is of a rather arbitrary nature, since we cannot determine these errors. Apart from that, these two stars are located at a considerable distance from the Zodiac, close to the relatively poorly-measured celestial region *M*.

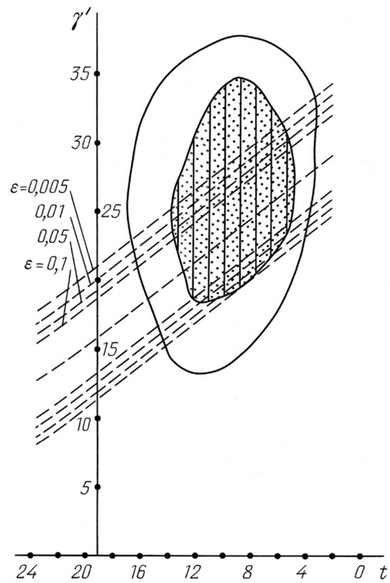


Fig. 7.25. A result of the statistical procedure that involved the dating of the Almagest catalogue by 6 of its named stars.

Let us now ponder the possible dating interval of the Almagest catalogue as it shall be if we exclude these two stars and leave just six of them in the informative kernel of the catalogue, namely, Arcturus, Regulus, Antares, Spica, Aselli and Procyon. We can see the result in fig. 7.25 (similar to fig. 7.11). Although the value area of parameter γ for which the maximal latitudinal discrepancy does not exceed the level of 10' or 15' has grown substantially, the boundaries of the possible dating interval only changed very marginally. The top boundary remains the same for both levels; the lower boundary for the 15-minute level remains the same as compared to the one we get when we consider the eight kernel stars. The lower boundary for α = 10' moved backwards in time by a mere 100 years.

Thus, if we are to take into account nothing but the 6 named stars of the Almagest catalogue from area *Zod A* or its immediate vicinity, we can come to the conclusion that the Almagest star catalogue could not have been compiled earlier than 500 A.D.

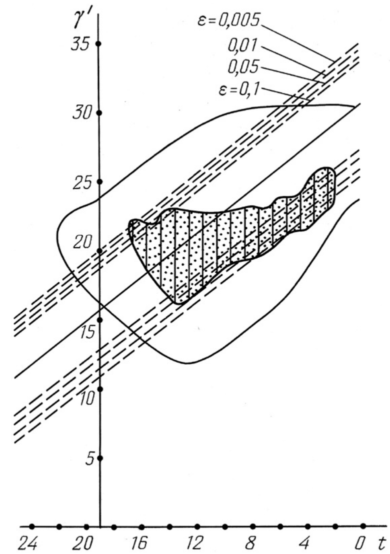


Fig. 7.26. A result of the statistical procedure that involved the dating of the Almagest catalogue by 7 of its named stars.

6.4. The exclusion of Arcturus does not affect the dating of the Almagest catalogue substantially

We are confronted with yet another question. Could the Almagest catalogue dating interval that we have calculated be the result of just one star moving? This question does make sense, since if we are to find such a star, the possible error in how its coordinates were measured can distort the resultant dating. The only candidate for such role of a "dating star" in the informative kernel is Arcturus. It is the fastest of all eight stars, and it defines our dating interval to a large extent. The stars that surround it weren't measured very well, qv in Chapter 6. Therefore, if the individual coordinate error for Arcturus is great enough, the possible dating interval can become rather distorted. Let us check what this interval shall be like if we exclude Arcturus from the informative kernel of the Almagest catalogue, limiting it to just seven stars. The length of the new interval shall naturally extend, since it is basically inversely proportional to the maximum stellar speed of the catalogue's informative kernel. We can see the result as a diagram in fig. 7.26, which demonstrates clearly that even with the fastest star of the informative kernel (Arcturus) absent, the 10-minute area does not go further back in time than 300 A.D. ($t = 16$) at the trust level of $1 - \varepsilon = 0.95$ or lower. It is only if we are to extend the confidence strip to $1 - \varepsilon = 0.99$, or 99%, that this area begins to cover 200 A.D., which is to say that the Scaligerian epoch of Ptolemy is not included into the dating interval, let alone the even more ancient Scaligerian epoch of Hipparchus.

Let us now consider the 15-minute area. It reaches 100 B.C. ($t = 20$) at the trust level of $1 - \varepsilon = 0.95$. Trust level of $1 - \varepsilon = 0.99$ allows to reach 200 B.C. – therefore, the Scaligerian epoch of Ptolemy is only covered if we are to make the conditions extremely lax.

One wonders whether the trust level of $1 - \varepsilon = 0.95$ is sufficient in our case. Apparently so, since the precision defined by a level of 95% is high enough for historical research; actually, such values are considered acceptable for technical applications as well, and those require a very high level of precision indeed. Let us cite [273] for reference, which is a work concerned with the dating of the Almagest, for which we have chosen the value of $\varepsilon = 0.2$ making the confidence interval a mere 80%. Therefore, our conclusions do have a very high degree of reliability.

We can conclude saying that neither the change of trust level, nor the alterations in the contingent of the informative kernel, nor the variation of the guaranteed measurement precision value can affect the primary conclusion that we made, namely, that the Almagest catalogue was compiled a great deal later than I-II century A.D., which is the Scaligerian epoch of Ptolemy.

7.
THE GEOMETRICAL DATING OF THE ALMAGEST

The conclusions that we came to in sections 2-6 have all been of a statistical character. The actual group error values were determined with some statistical error. Therefore, the conclusions regarding the group error coincidence for various Almagest constellations can be false, albeit this probability is very low indeed, since we analysed the stability of our statistical result in the previous section. However, in order to guarantee the absence of statistical errors, let us set statistics aside for a while and turn to purely geometrical considerations.

Let us consider the "minimax latitudinal discrepancy" for the previously defined informative kernel of the Almagest catalogue that consists of 8 named stars:

$$\delta(t) = \min \Delta(t, \gamma, \varphi), \qquad (7.7.1)$$

where the minimum is selected according to various values of γ and φ, and then compare this equation to 7.3.1. The sole difference between them is the altered value range of parameter γ. In formula 7.3.1 γ would change inside the scope of the confidence strip that covers point $\gamma_{stat}(t)$. Equation 7.7.1 contains no such limitation; therefore, $\delta(t) \le \Delta(t)$.

Let us use $\gamma_{geom}(t)$ and $\varphi_{geom}(t)$ to represent the values of γ and φ that comprise the minimum of the right part (7.7.1). Possible low precision of the $\gamma_{geom}(t)$ and $\varphi_{geom}(t)$ estimation procedure is of little importance here.

Let us recollect the situation we already encountered in Section 3 where we removed the limitations from parameter φ. These limitations only concerned γ. As we have seen, it leads to a dating interval that remains unaffected by the statistical estimation char-

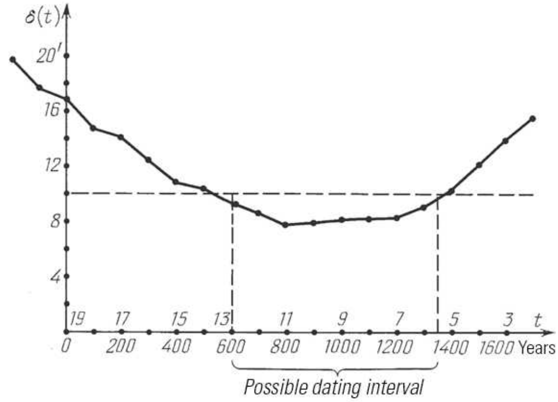


Fig. 7.27. Geometrical procedure of dating the Almagest catalogue: $\delta(t) = \Delta_b(t, \gamma_{geom}(t), \varphi(t))$.

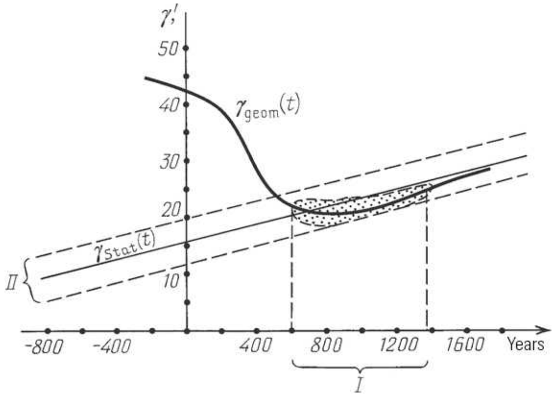


Fig. 7.28. $\gamma_{geom}(t)$ dependency graph together with the trust interval.

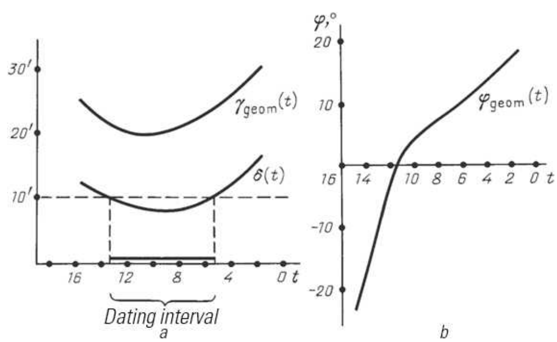


Fig. 7.29. The geometrical dating procedure of the Almagest catalogue.

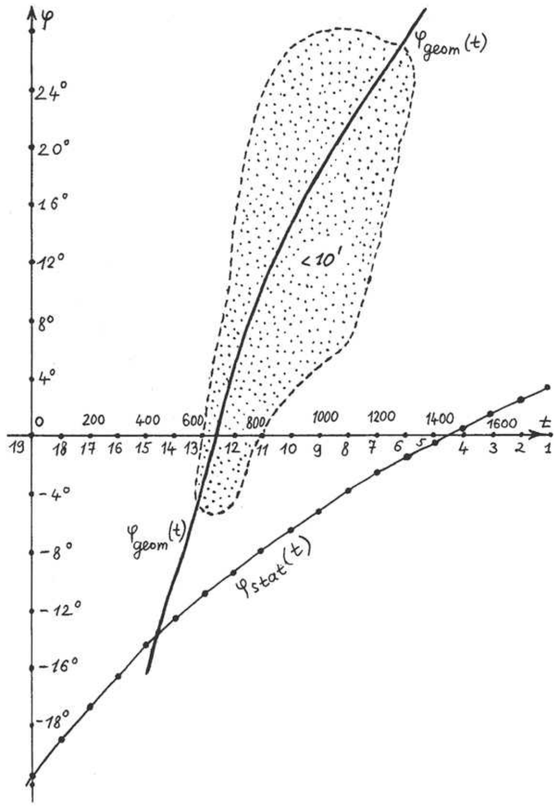


Fig. 7.30. The geometrical dating procedure of the Almagest catalogue.

acteristics of φ. The interval is nonetheless a large one. We shall do something of the kind with both parameters (γ, φ). The values of $\gamma_{geom}(t)$ and $\varphi_{geom}(t)$ that we have introduced can be considered parameters defining the group error of the catalogue's informative kernel, provided the catalogue was compiled in a certain epoch t.

Taking all of the above into account, let us consider the possible dating interval of the catalogue to be all of these time moments t taken as a whole, for which $\delta(t) \leq 10'$. In order to find this interval, let us draw the graph of $\delta(t)$ in figs. 7.27, 7.28, 7.29 and 7.30., as well as the graphs of the functions $\gamma_{geom}(t)$ and $\varphi_{geom}(t)$. The resulting graph of $\delta(t)$ was built according to the formula 7.7.1, and the values of $\Delta(t, \gamma, \varphi)$ were calculated by 7.3.1, with the subsequent sorting out by γ and φ. For comparison, we can study the $\varphi_{geom}(t)$ dependency graph in fig 7.28 complete with the confidence strip (see section 6). One also sees the area of such values of (t, γ) for which $\Delta(t, \gamma, \varphi) < 10'$ with a certain value of φ.

According to these graphs, the previously estimated Almagest catalogue dating interval does not expand even if we are to use a geometrical dating procedure. This is additional proof to the fact that our statistical estimations of γ_{stat}^{ZodA} calculated for the majority of the Almagest catalogue stars do in fact correspond to the group error in the small array of named Almagest stars. Apart from that, we prove that there is no option to combine the real celestial sphere with the Almagest stars in such a way that all the stars would have a latitudinal discrepancy of less than 10' anywhere outside the interval between 600 A.D. and 1300 A.D.

We shall conclude with citing the presumed dating t dependency graphs for the individual latitudinal discrepancies of all 8 stars from the informative kernel of the Almagest at fixed values of $\gamma = 20'$ and $\varphi = 0$ (see fig. 7.31). The upper envelope of these graphs is similar to the curve in fig. 7.25 that represents the dependency of the minimal discrepancy on the presumed dating t for the greater part of the time interval after 0 A.D. ($0 < t < 9$). This results from the value of $\gamma = 20'$ being close to that of $\gamma_{geom}(t)$, whereas $\varphi = 0$ is close to $\varphi_{geom}(t)$ for the greater part of this interval. The result is not particularly sensitive to the variation of the φ value.

Fig. 7.31 demonstrates which exact stars of the Almagest catalogue's informative kernel allow to reach the minimal value of the latitudinal discrepancy $\delta(t)$ for different presumed datings t. In fig. 7.31 one can plainly see the concentration of zero latitudinal discrepancy values near $t = 10$, or approximately 900 A.D. This presumed catalogue dating virtually eradicates the discrepancies for three informative kernel stars simultaneously, namely, Arcturus (α Boo), Regulus (α Leo) and Procyon (α CMi). For all the other informative kernel stars of the Almagest catalogue it is only the latitudinal discrepancy of Aselli (γ Can) that reaches zero near the beginning of the new era.

It would be interesting to examine a possible link between the abovementioned zero discrepancy concentration and the fact that Arcturus and Regulus, as well as Sirius, occupied an exceptionally important

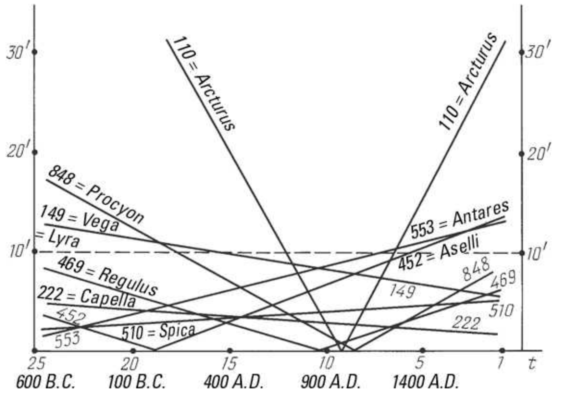


Fig. 7.31. Individual latitudinal discrepancies of the Almagest catalogue with $\beta \approx 0'$, $\gamma \approx 21'$.

position in "ancient" astronomy. Arcturus, for instance, must have been the first star to have received a name of its own in "ancient" Greek astronomy, being the brightest star of the Northern hemisphere. It is mentioned in an "ancient" poem by Aratus that contains references to the celestial sphere. Regulus is the star that was used for reference for measuring the coordinates of all other stars and planets in Greek astronomy.

8. THE STABILITY OF THE GEOMETRICAL DATING METHOD APPLIED TO THE ALMAGEST CATALOGUE. The influence of various astronomical instrument errors on the dating result

8.1. Poorly-manufactured astronomical instruments may have impaired the measurement precision

The geometrical dating method does not contain trusted probability factor ε. However, one has to test its stability in relation to the declared catalogue precision as well as the informative kernel contingent. The conclusions we come to here are similar to the ones of section 6 to a large extent. Thus, raising the precision level from 10' to 15' leads to shifting the lower boundary of the dating interval back to 250 A.D. The dating interval for the compacted informative kernel of 6 stars which are either located in area *Zod A* or in its immediate vicinity also only grew by a mere 100 years, becoming 500 A.D. – 1300 A.D. Once we remove the fast Arcturus from the informative kernel of the catalogue, the dating interval expands to 200 A.D. – 1600 A.D.

Therefore, the Almagest catalogue dating interval as estimated by a geometrical procedure fails to cover the Scaligerian epoch of Ptolemy, let alone the Scaligerian Hipparchus.

Apart from that, we shall demonstrate the stability of the geometrical dating procedure under the possible influence of astronomical instrument errors.

The geometrical dating method is based on accounting for the observer's error in the ecliptic pole estimation. All the possible rotations of the sphere, or, in other words, the orthogonal rotation of the coordinate grid in space, are taken into account. If we're interested in nothing but the latitudes, the rotation of the sphere can be defined solely by the pole shift vector, since the residual rotation component does not affect the latitudes.

Let us assume the pole shift vector to have the coordinates of (γ, φ). If we can make the sphere rotate in such a manner that will reduce the maximal latitudinal discrepancy (of the informative kernel of the catalogue, or the zodiacal stars contained therein, for instance, and so on) to a value lower than that of Δ, the dating of the catalogue is a feasibility. Let us remind the reader that for the Almagest catalogue $\Delta = 10'$.

In all of the cases considered above, orthogonal rotations of the celestial sphere sufficed in order to make the maximal latitudinal discrepancy lower than the declared precision rate of catalogue Δ, ipso facto dating the catalogue and also confirming the precision of Δ as declared by Ptolemy. However, we have so far left the fact that Ptolemy might have used an imperfect astronomical instrument out of consideration. An example could be an astrolabe with metallic rings with a slight aberration of the perfect circular shape. A ring could be oblate from one end and stretched from another. Apart from that, some of this instrument's planes could be not quite as perpendicular in reality as they should have been ideally. Some of the angles could become warped as a result and give somewhat different scales on different axes.

In other words, the instrument, as well as the coordinate grid that it would define in three-dimensional space, could be subject to a certain deformation. It could affect the measurement results setting them off the mark. One is well entitled to wonder about how minor deformations of the instrument – or, in other words, the coordinate grid that said instrument corresponds to, influence the result of the measurement. How great should the instrument's distortions be to substantially impair the results of the observations? We answer all of these questions below.

8.2. Formulating the problem mathematically

Let us formulate the problem in precise mathematical terms. We shall consider a three-dimensional Euclidean space whose centre contains a sphere that corresponds to three mutually orthogonal coordinate axes. These axes define pairs of orthogonal coordinate planes. In order to measure ecliptic stellar coordinates, one would have to project the star from the beginning of the coordinate scale into point *A*, qv in fig. 7.32. The resultant point *A* on the sphere is defined by its coordinates – spherical, for instance. These coordinates are then included into the observer's catalogue.

Let us now consider the axis *z* to be directed at the ecliptic pole *P*, whereas plane *xy* crosses the ecliptic of the sphere. We have already made a detailed explanation of the fact that stellar latitudes are the most reliably measured coordinate. Therefore it is the latitude of star *A* that shall be of the utmost interest to us. The latitude is measured across the meridian that connects ecliptic pole *P* to star *A*. Zero latitude is the ecliptic itself, or parallel zero. In fig. 7.32 the ecliptic latitude of star *A* is measured by the length of arc *AB*.

The process of inclusion of stellar coordinates as described above has the implication that the observer's instrument creates an ideal spherical coordinate system in the surrounding three-dimensional space. However, the real instrument might be somewhat deformed. Disregarding the second-order effects and without loss of generality in any way one can consider the instrument's deformation to cause some sort of linear space transformation of the Euclidean coordinate system. It would be natural to consider this linear transformation close to an identical case, since too great a distortion would be noticed by the observer who claims the precision of 10', as we have already seen. Even if the deformation of the coordinate system contains small non-linear perturbations, we are de facto considering the first linear approximation that describes the instrument's distortion.

A linear transformation of three-dimensional space that leaves the beginning of the coordinates intact is specified by the matrix

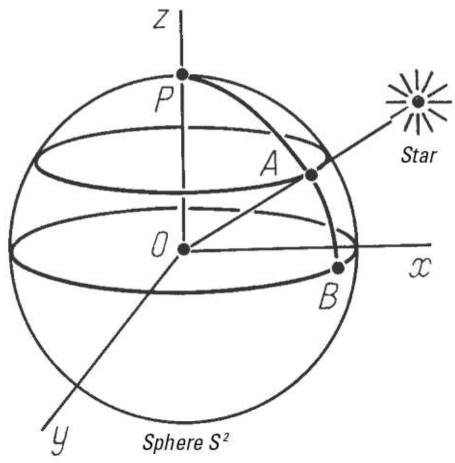


Fig. 7.32. The calculation of a star's ecliptic latitude.

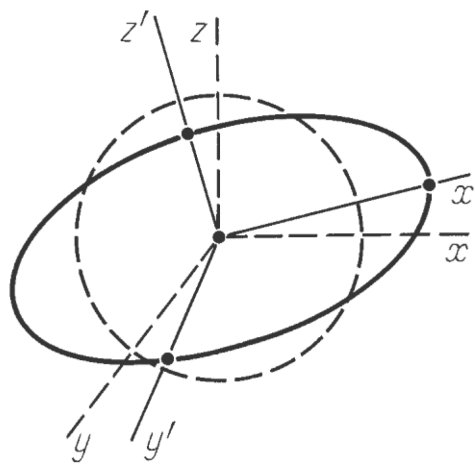


Fig. 7.33. The transformation of a sphere into an ellipsoid under the influence of minor linear deformation of the ambient space.

$$C = \begin{pmatrix} c_{11}c_{12}c_{13} \\ c_{21}c_{22}c_{23} \\ c_{31}c_{32}c_{33} \end{pmatrix}$$

This transformation distorts the original Euclidean coordinate system. Elementary quadratic form theory tells us explicitly that non-degenerate linear transformation close to the identical deforms a sphere making it an ellipsoid of sorts, qv in fig. 7.33. Thus, although the original mutually orthogonal coordinate lines are somewhat shifted, ceasing to be orthogonal, one can always find three new mutually orthogonal lines aligned along the ellipsoid axes. These three new lines are indicated as x', y' and z' in fig. 7.33.

Thus, the ends of our research allow us to assume that the linear transformation deforms the sphere in the following manner: the first thing that happens is some kind of turn (orthogonal transformation) that turns the mutually orthogonal axes x, y and z into new mutually orthogonal axes x', y' and z'. This last transformation is specified unambiguously by the diagonal matrix

$$R = \begin{pmatrix} \lambda_1 0 & 0 \\ 0 & \lambda_2 0 \\ 0 & 0 & \lambda_3 \end{pmatrix}$$

Stretching coefficients λ_1, λ_2 and λ_3 represent certain real numbers which can be positive or negative, but the very concept of the problem implies that they differ from zero.

8.3. The deformation of a sphere into an ellipsoid

The deformations of the coordinate grid which were caused by orthogonal turns have been studied above, and so one can now concentrate all of one's attention on the second transformation, namely, the transformation of the similarity defined by diagonal matrix R.

Thus, without loss of generality we can assume the deformation of the astronomical instrument that spawns a linear transformation of the three-dimensional Euclidean coordinate grid is specified by similarity transformation R with stretching coefficients λ_1, λ_2 and λ_3, qv in fig. 7.34. Let us point out that the values of λ_i can equal one, be greater than one or smaller than one independently from each other. Therefore when we are referring to stretching coefficients, in reality it isn't just the factual stretching (or linear size expansion along the axis), but also the possible compression, or linear size reduction. If λ_i is greater than 1 for some i, we have expansion; if its value is smaller than one, we observe compression to take place on the axis in question.

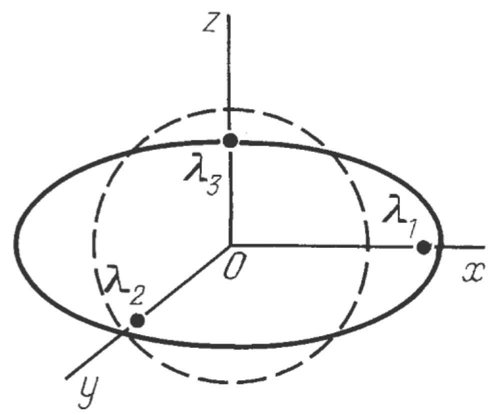


Fig. 7.34. The transformation of the similarity with independent coefficients of expansion or compression along the three orthogonal axes.

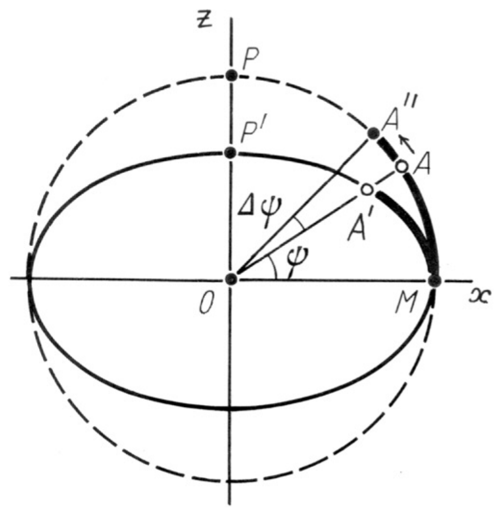


Fig. 7.35. The distorted latitudes of observed stars as a result of minor coordinate system distortion arising from imperfections in the manufacture of the astronomical measuring instruments.

The values of λ_1, λ_2 and λ_3 can be regarded as the semi-axis values of the ellipsoid. In fig. 7.34 these semi-axes are represented with the segments $O\lambda_1$, $O\lambda_2$ and $O\lambda_3$.

8.4. Measurement discrepancies in the "ellipsoidal coordinate system"

Let us proceed to discuss the coordinate changes in the deformed coordinate system as described above – one that we shall be referring to as "ellipsoidal". In fig. 7.35 the plane of the drawing crosses the centre *O*, star *A* and ecliptic pole *P*. This plane intersects the ellipsoid created by the instrument along the ellipse which is drawn in fig. 7.35 as a continuous curve. The respective circumference of an ideal instrument is drawn as a dotted curve. Since we're only interested in the latitudes, let us remind the reader that those are most commonly counted off the ecliptic point, or point *M* in fig. 7.35, used as a point of reference. The observer divided arc *MP'* into 90 equal parts, thus having graded the ring (or ellipse) with degree marks. Since it was an ellipse and not a circle that we graded, the uniform grade marks on the ellipse distort the angles to some extent which therefore makes the grading non-uniform. We are assuming that the observer failed to have noticed this, otherwise the instrument would have been adjusted.

After the observation, the position of the real star *A* was marked by the "elliptic instrument" as *A'*. The observer would consider this to be the real latitude of the star and write it down in his catalogue, which naturally presumes the coordinate system to be ideally spherical; it would therefore become transcribed as a certain point *A"*. The real position of the star would therefore become shifted and lowered somewhat if $1 = \lambda_1 > \lambda_3$.

Should the nature of the ellipse make point *P'* located above point *P* (with $1 = \lambda_1 < \lambda_3$, in other words), the star will be shifted in a different direction. In this case point *A"* shall be higher than point *A* on circumference *PM*. The resulting transformation of the circumference (*A* to *A"*) is naturally of a non-linear nature. It can be continued until the transformation of the entire plane and the entire three-dimensional space. The initial coordinate reference point would remain the same all the time. However, since we consider the distorting effect of the instrument to have been minor, it will suffice to study the linear approximation, as we mention above. In other words, it shall not result in too great an error if we use the main linear part instead of the entire non-linear transformation as described above. This main part is manifest as a stretching by the three orthogonal axes with coefficients of λ_1, λ_2 and λ_3.

We are thus returned to the mathematical formulation of the problem as related above (see sections 8.2 and 8.3). Precise values of the errors introduced into stellar latitudes by this transformation were computed by the authors; the results of the computations are cited in table 7.4.

b	ε =						
	–0.02	*–0.01*	*–0.004*	*0*	*0.004*	*0.01*	*0.02*
10°	5.0'	3.0'	1.0'	0	–1.0'	–3.0'	–5.0'
20°	11.0'	5.5'	2.0'	0	–2.0'	–5.5'	–11.0'
30°	15.0'	7.5'	3.0'	0	–3.0'	–7.5'	–15.0'
40°	17.0'	8.5'	3.4'	0	–3.4'	–8.5'	–17.0'
50°	17.0'	8.5'	3.4'	0	–3.4'	–8.5'	–17.0'
60°	15.0'	7.5'	3.0'	0	–3.0'	–7.5'	–15.0'

Table 7.4. Quantitatively calculated error values inherent in stellar latitudes and resulting from imperfections in shape of the astrolabe's rings. Here, $\lambda_3 / \lambda_1 = 1 + \varepsilon$. The angular distortion values are given in minutes and fractions of minutes.

8.5. Estimating the distortion of angles measured by the "marginally ellipsoidal instrument"

Let us therefore consider a linear transformation of three-dimensional space defined by three values λ_1, λ_2 and λ_3, or the matrix

$$R = \begin{pmatrix} \lambda_1 & 0 & 0 \\ 0 & \lambda_2 & 0 \\ 0 & 0 & \lambda_3 \end{pmatrix}$$

We have to estimate the resultant angle distortion. Let ψ equal the true latitude of a real star. If it is measured by an ellipsoidal instrument, it will transform into a different value ψ'. The difference $\Delta\psi = \psi - \psi'$

is the value of the real distortion. Geometrically, the distortion is specified by the angle $\Delta\psi$ between the direction of the real star and the direction measured by a deformed instrument.

We find that it isn't necessary to consider the entire three-dimensional space, and that a flat plane case should suffice after all. Indeed, fig. 7.36 demonstrates that linear transformation R shifts star A into the new position A'', while the parallel of star A shall transform into the parallel of star A''. This is a result of the plane being orthogonal to axis OP and defining the parallel of star A. It will occupy a new position, remaining orthogonal to axis OP. Since it is just the latitudes that we're interested in, it shall suffice to study point B instead of A'' – one that lies upon the meridian of star A, qv in fig. 7.36.

Transformation R makes the plane that crosses axis OP and the meridian of star A rotate around axis OP. The shifted plane generates a linear transformation of the similarity; the three-dimensional problem thus becomes two-dimensional, and so we shall be studying the ellipse in two dimensions, qv in fig. 7.37. Disregarding the previous indications, let us introduce Cartesian coordinates (x, z) to the plane and consider the linear transformation

$$R = \begin{pmatrix} \lambda_1 & 0 \\ 0 & \lambda_3 \end{pmatrix},$$

defined by the stretchings λ_1 and λ_3 along the respective axes of x and z.

The position of star A is specified on a unit circumference by radius-vector $a = (x, z)$, and the position of the "shifted star" marked B – by radius-vector $b = (\lambda_1 x, \lambda_3 z)$. Our goal is to calculate the angle $\Delta\psi$ as a function of the initial latitude ψ and stretching (compression) coefficients λ_1 and λ_3.

8.6. Possible distortion estimation and the stability of the resultant dating

According to elementary theorems of analytical geometry, $\cos\Delta\psi$ is equal to the scalar product (a, b) of vectors a and b divided by the length of vector b. The radius of circumference OM is naturally presumed to equal 1, which can always be attained via scale choice. Thus,

$$\cos\Delta\psi = \frac{\lambda_1 x^2 + \lambda_3 z^2}{\sqrt{\lambda_1^2 x^2 + \lambda_3^2 z^2}}.$$

Let $\lambda = \lambda_3 / \lambda_1$ and $\lambda = 1 + \varepsilon$. Then

$$\cos\Delta\psi = \frac{x^2 + \lambda z^2}{\sqrt{x^2 + \lambda^2 z^2}} = \frac{1 + \varepsilon z^2}{\sqrt{1 + 2\varepsilon z^2 + \varepsilon^2 z^2}}.$$

Let $m = 1 / \cos\Delta\psi$, then $m \geq 1$. Squaring shall give us

$$1 + 2\varepsilon z^2 + \varepsilon^2 z^2 = m^2 + 2m^2 \varepsilon z^2 + m^2 \varepsilon^2 z^4.$$

Thus,

$$\varepsilon = \frac{m^2 - 1}{1 - m^2 z^2} + \sqrt{\frac{m^2 - 1}{(1 - m^2 z^2) z^2} + \left(\frac{m^2 - 1}{1 - m^2 z^2}\right)^2}.$$

If the value of $\Delta\psi$ is small, $m \approx 1$ and can be transcribed as

$$m = 1/\cos\Delta\psi \approx 1 + (\Delta\psi)^2/2.$$

Therefore,

$$m - 1 \approx (\Delta\psi)^2/2, \quad 1 - m^2 z^2 \approx 1 - z^2.$$

Finally, for small values of $\Delta\psi$ we have

$$\varepsilon \approx \sqrt{\frac{m^2 - 1}{(1 - m^2 z^2) z^2}} \approx \sqrt{\frac{(m-1)(m+1)}{(1 - z^2) z^2}} \approx \sqrt{\frac{(\Delta\psi)^2}{(1 - z^2) z^2}} = \frac{\Delta\psi}{z\sqrt{1 - z^2}}.$$

However, $z = \sin\psi$ and $\sqrt{1 - z^2} = \cos\psi$, qv in fig. 7.37. And therefore we shall get the following for small values of $\Delta\psi$:

$$\varepsilon \approx \frac{\Delta\psi}{\sin\psi \cos\psi} = \frac{2\Delta\psi}{\sin 2\psi},$$

which implies that $\Delta\psi = \frac{\varepsilon}{2} \cdot \sin 2\psi$.

Now let us find actual numerical estimations of ε. Bear in mind that $\lambda_3 / \lambda_1 = 1 + \varepsilon$, which means the value of ε demonstrates the distortion rate of the coordinate system. The values that we use in our formulae are convenient to express in radians. Thus: $1° = \pi / 180$; $1' = 1° / 60 = 3.14/(60 \times 180) \approx 4.35 \times 10^{-4}$, or $1' \approx 0.00044$.

Therefore, for sensible values of ε, or instrument errors invisible to naked eye, the latitudes of the stars which are close to either the pole or the ecliptic are only marginally distorted. The matter is that $\sin 2\psi$ tends to zero in such cases, which should tell us that

sensibly possible instrument errors cannot significantly affect the result of measuring the stars that possess small and large latitudinal values – latitudes close to 0° and 90°, in other words. The maximal latitudinal aberrations are to be expected from the stars located at a large distance from both the pole and the ecliptic pole.

Let us provide the precise quantitative estimates using the actual star catalogue material – the Almagest, for instance. As one can see from fig. 7.27, the maximal latitudinal discrepancy graph of the Almagest's informative kernel grows rather rapidly both on the left and on the right of the interval between 600 A.D. and 1300 A.D. This makes one wonder whether taking the instrument errors into account would allow us to nullify or minimize this latitudinal discrepancy – around the beginning of the new era, for instance, which is the epoch when the Almagest was created, according to the Scaligerian version of chronology.

In other words, we wonder whether one can find any proof to the Scaligerian hypothesis that the Almagest star catalogue was created at some point in time that is close to the beginning of the new era. However, the observer is presumed to have used a somewhat deformed instrument which resulted in a certain error introduced into stellar latitudes. Will taking this error into account permit dating the catalogue to an epoch that will be closer to the beginning of the new era?

We shall demonstrate this to be impossible. Let's presume the measurement results were impaired by the deformed astronomical instruments and take these errors into account in order to minimize the latitudinal discrepancy of the informative kernel of the Almagest under the assumption that the stars were observed around the beginning of the new era. However, we already calculated this discrepancy to be rather substantial – its minimum is 35' for 0 A.D. Can this be rectified by the choice of a fitting ε value?

It was demonstrated above that the minimization of the latitudinal discrepancy for the stars with small and large latitudinal values is hardly possible at all; however, we could try it for the stars whose latitudes are close to 30°-40°. The informative kernel of the Almagest catalogue contains Arcturus; its latitude equals 31 degrees. Furthermore, since Arcturus possesses a high proper movement speed, it is the primary factor to produce the maximal latitudinal discrepancy of the informative kernel around the beginning of the new era. Fig. 7.31 demonstrates that the individual latitudinal discrepancy graph of Arcturus makes this discrepancy reach 35' around the early A.D. period. So let us enquire whether a substantial discrepancy reduction within the vicinity of

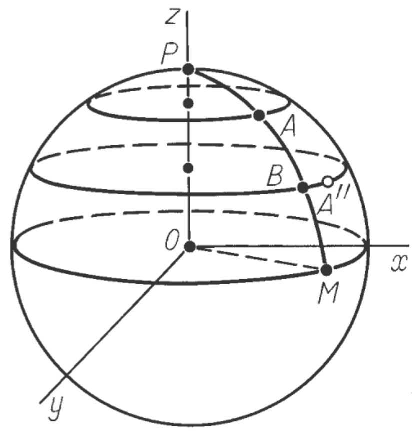


Fig. 7.36. As a result of linear transformation of the coordinate system, the star shall "alter its position" (here $\lambda_1 = 1$).

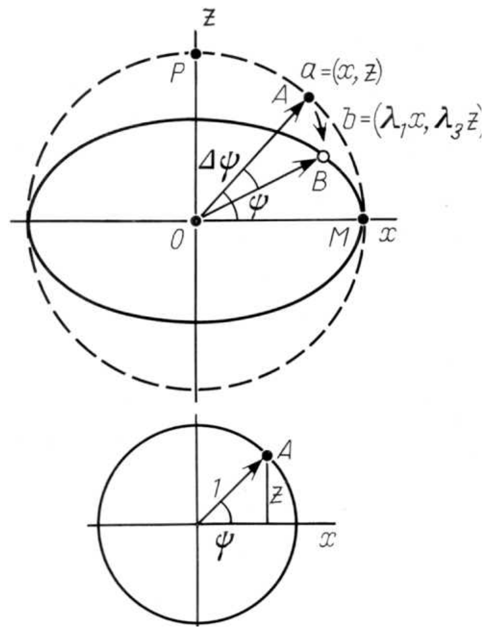


Fig. 7.37. The transformation of a circumference into an ellipsis as a result of a minor coordinate system distortion.

the Scaligerian dating of the Almagest catalogue is a possibility at all, assuming that the observer's instrument was deformed?

Let us calculate the value of ε. As it has been pointed out above, Almagest catalogue precision rate Δ equals 10' as declared by the compiler. Therefore, in order to vanquish the latitudinal discrepancy for Arcturus it has to be reduced from 35' to 10', making the latitude smaller by a factor of 25'. Thus, we have to find such a value of ε that will make Δψ equal 25'. Δψ = 0.01 in radians. The formula for ε immediately tells us that

$$\varepsilon \approx \frac{0.01}{\sin 30^\circ \cos 30^\circ} \approx 0.04.$$

Thus, ε should be approximately equal to 0.04. Only such instrumental distortions could explain the latitudinal discrepancy of Arcturus as observed in the early A.D. epoch. However, this value of ε is excessive; for instance, if the radius of an astrolabe equals 50 centimetres, the instrument has to be deformed to such an extent that one of the semi-axes would equal 52 cm; that is to say, the error has to manifest as a 2 cm deformation! One can hardly allow for such low precision of an astronomical device – otherwise we shall also have to assume that cartwheels were made with more precision in Ptolemy's epoch than astrolabes.

8.7. Numerical value table for possible "ellipsoidal distortions"

Above we cite a table of exact distortion values arising from the measurements of stellar latitude made with a certain instrument – an astrolabe, for instance, which would have a deformed latitudinal ring. Let us point out that the latitudinal error rate of star *A* depends on the value of the real latitude of *A* as well as the value of $\lambda = R_3 / R_1$. Here R_1 and R_3 are the semi-axes of the instrument's ellipsoidal latitudinal ring. As above, let us assume that $\lambda = 1 + \varepsilon$. Then the value of $\varepsilon = 0$ shall correspond to the ideal ring when the ellipse becomes a circumference. The discrepancies in this case shall equal zero for all the latitudes. As one can see from table 7.4, the maximal absolute values of errors appear at the latitude of 45 degrees, which is also easy to demonstrate theoretically. Table 7.4 contains the values of the difference $b' - b$, where b is the precise value of a star's latitude, and b' – the value of the latitude measured by the marks on the ellipsoidal rings with parameter $\lambda = 1 + \varepsilon$. The values of b and ε are the table entries; the values of distortions $b' - b$ were calculated quantitatively, with the use of a computer.

Table 7.4 demonstrates just what error rate we consider acceptable, replacing the non-linear coordinate grid transformation as considered above by its main linear part. Taking this error into account does not affect our conclusions concerning the impossibility of allowing for Ptolemy's instrument to have been deformed to such an extent that would allow the dating interval to cover the Scaligerian Almagest epoch – I-II century A.D.

8.8. Conclusions

1) It is theoretically possible that a deformed astronomical instrument would produce a spatial coordinate system subject to a certain linear transformation.

2) One can theoretically calculate the dependency between the instrument distortion coefficient ε and the resultant error in stellar latitude estimation.

3) The data contained in actual catalogues (such as the Almagest) allow for an estimation of the numerical values of ε and Δψ.

4) No sensible deformations of the astronomical instrument can explain the gigantic latitudinal error discovered in the Almagest catalogue (assuming that the observations were conducted around the beginning of the new era.

9. LONGITUDINAL BEHAVIOUR OF THE NAMED ALMAGEST STARS

We considered the catalogue's latitudes separately from the longitudes in our dating efforts. We discovered that the latitudinal precision of the Almagest is a great deal higher than the longitudinal. It was the analysis of the latitudes that allowed us to build an informative possible dating interval for the Almagest catalogue.

We have naturally conducted all the necessary calculations in order to check the dating that one ends

up with using the longitudes instead of the latitudes. As one should have expected if one took the results of our preliminary analysis into account, it turned out that one cannot date the Almagest catalogue to any point on the interval between 1000 A.D. to 1900 A.D. by stellar longitudes, since their precision in the Almagest catalogue is too low.

We shall study the possibility of using both the latitudes and the longitudes for the dating of the Almagest catalogue in the next section.

Let us now regard the dating of the Almagest that we end up with using longitudes and not latitudes as a basis.

We shall use $L_i(t, \gamma, \varphi)$ for referring to the latitude of star i taking into account the rotation angles of the celestial sphere – γ and φ. Bear in mind that what these indications stand for is the compensation of the possible error in the position of the ecliptic. The error is defined by parameters γ and φ. In order to make our conclusions more precise, we shall only consider the 6 named Almagest catalogue stars from celestial area *Zod A* and its immediate vicinity, namely, Arcturus, Regulus, Antares, Spica, Aselli and Procyon. In Chapter 6 we managed to learn that the group error γ coincides with the value of γ_{stat}^{ZodA} for these six stars.

Let us calculate the values of $L_i(t, \gamma_{stat}^{ZodA}(t), \varphi_{stat}^{ZodA}(t))$ for these stars, or their latitudes after the compensation of the respective group error for epoch t. One can naturally make an error here, and a significant one at that for two reasons at the very least. The first is that parameter φ greatly affects the values of the longitudes. At the same time, we have observed that there is no stability in the estimation of this parameter; therefore, one can by no means guarantee that it is the same for all six stars and equals φ_{stat}^{ZodA}. The second reason is as follows. We did not consider group errors in longitude above, which may very well exist, qv in [1339]. Their analysis leads to the necessity of introducing yet another value that would parameterise the group error. Parameter τ can serve as such, qv in Chapter 3. It stands for the celestial sphere's rotation angle around the two new ecliptic poles defined by parameters γ and φ.

Let us define $\Delta L_i(t) = L_i(t, \gamma_{stat}^{ZodA}(t), \varphi_{stat}^{ZodA}(t)) - l_i$. If we draw a function graph for $\Delta L_i(t)$, we could represent it as a sum of an almost linear function (even longitudinal variation resulting from precession) and the irregular "addition" corresponding to all sorts of errors.

Therefore, in order to exclude the effects of precession as well as the possible systematic error τ from consideration, let us introduce the value

$$\Delta \overline{L}(t) = \frac{1}{6}\sum_{i=1}^{6} \Delta L_i(t).$$

$\Delta \overline{L}(t)$ is a rather precise value that measures the longitudinal shifts of the 6 stars under study that result from precession. Let us assume that

$$\Delta L_i^0(t) = \Delta L_i(t) - \Delta \overline{L}(t).$$

The value $\Delta \overline{L}_i^0(t)$ is hardly affected by precession at all.

In fig. 7.38 one sees the changes of $\Delta \overline{L}_i^0(t)$ as functions of the presumed t dating for six Almagest stars considered herein. The first implication of the picture is the low variation velocities of $\Delta \overline{L}_i^0(t)$ values over the course of time. After the compensation of precession, the "fast" stars of the Almagest turn out to be very "slow" insofar as the longitudes are concerned. For instance, the longitude variation velocities of Arcturus and Regulus are almost equal to one another. Procyon becomes the fastest star of six; however, its longitude over 3000 years (between 1100 B.C. and 1900 A.D.) is only altered by 17', which is slightly over 5' per millennium. These slow longitudinal changes are obviously insufficient for an informative dating.

In fig. 7.39 we can see two graphs that could theoretically serve our dating ends. However, the behaviour of these graphs testifies to their utter uselessness in this capacity. Let us consider the two following functions in particular:

$$\Delta L_{\max}(t) = \max_i \left|\Delta L_i^0(t)\right| \,, \; \Delta L^0(t) = \max_i \Delta L_i^0(t) - \min_i \Delta L_i^0(t).$$

The first one corresponds to the maximal longitudinal discrepancy between the real stars under study and the ones found in the Almagest. The absolute value of the aberration is considered with the precession accounted for. The second function does not depend on precession, being the difference between the minimal and the maximal aberration. The function of $\Delta L_{max}(t)$ reaches its minimum at $t = 15$, or in 400 A.D.,

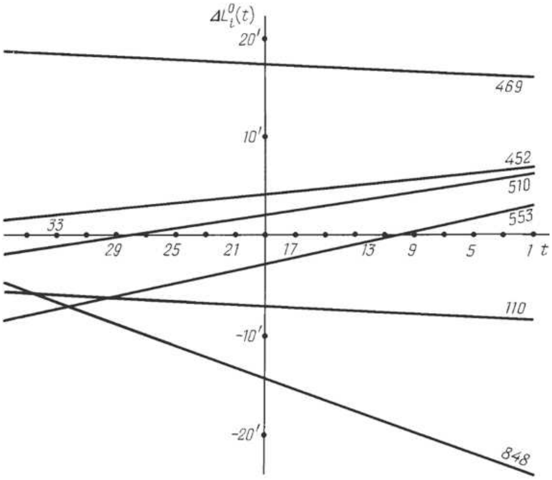


Fig. 7.38. Longitudes of six named stars (Arcturus = 110 in Bailey's enumeration, Regulus = 469, Procyon = 848, Antares = 553, Spica = 510, Aselli = 452) and their behaviour.

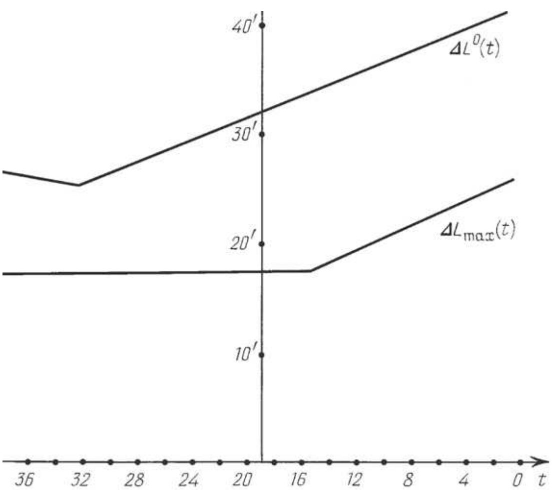


Fig. 7.39. The behaviour of the functions $\Delta L_{max}(t)$ and $\Delta L^0(t)$.

whereas function $\Delta L^0(t)$ does the same at $t = 32.5$, which roughly corresponds to 2350 B.C. Both functions assume considerably large values ($\Delta L^0(t) \geq 25'$, and $\Delta L^0(t) \geq 30'$ starting with the Scaligerian epoch of Hipparchus). Finally, $\Delta L_{max}(t) \geq 17'$. All of this demonstrates latitudinal precision to be too low as compared to proper movement speeds. It doesn't give us any idea as to what the real observation date might be.

Our calculations have thus confirmed that the longitudes of the Almagest catalogue aren't particularly informative due to their low precision rate. The real reason for it was apparently discovered by R. Newton ([614]). He claims that the Almagest longitudes have been forged by someone (also see Chapter 2). We conducted no in-depth research in this direction – it is well possible that a statistical analysis of the longitudes shall detect consecutive patterns in their behaviour. This might demonstrate the existence of group errors in certain parts of the Almagest catalogue, for instance. However, regardless of whether or not this happens to be true, our research demonstrates that it makes no apparent sense to use the longitudes for making the Almagest catalogue dating more precise.

10. THE BEHAVIOUR OF ARC DISCREPANCIES IN THE CONFIGURATION COMPRISED OF THE ALMAGEST INFORMATIVE KERNEL

In Chapter 3 we already mentioned the possibility of dating the catalogue via a comparative analysis of two configurations, one of them immobile and consisting of the Almagest stars, and the other mobile and comprised of modern stars. It was pointed out that this comparison does not require any references to Newcomb's theory – for instance, if it is just the arch distance differences that we have to consider. The use of this method makes us deal with the following hindrances: possible errors in star identification and the low coordinate measurement precision that leads to excessively large dating intervals, as well as the impossibility to differentiate between coordinates measured precisely and imprecisely with such an approach – latitudes and longitudes, for instance.

If we are to choose the Almagest catalogue informative kernel as the configuration under study, the first two hindrances become irrelevant. Indeed, the identity of the stars in question is known for certain, and our primary hypothesis implies their precision to be high enough – latitude-wise, at the very least. Apart from that, the informative kernel contains two stars that move at sufficiently high velocities – Arcturus and Procyon. It is obvious that the unknown error in longitude measurements can lead to dating errors beyond estimation. Nevertheless, the

fact that we don't need to consider group errors for this approach makes the corresponding calculations most remarkable. However, it is unfortunately impossible to estimate the errors of these calculations (basing such estimations on our research, at least).

Let us quote the results of the calculations that we have conducted in this direction for 8 of 6 named Almagest stars.

Let l_{ij}^A represent the arc distance between Almagest stars i and j. We shall assume l_{ij}^t to represent a similar distance between modern stars as calculated for observation moment $t = 1, \ldots, 25$. The number of stars in the configuration under study shall be represented by n. Let us mark

$$m_2(t) = \frac{2}{n(n-1)} \sum_{i>j} (l_{ij}^t - l_{ij}^A)^2,$$
$$m(t) = \sqrt{m_2(t)}.$$

The value of $m(t)$ can be considered as the generalized distance between the configuration calculated for epoch t and the respective configuration of the Almagest stars. The minimum points of the functions $m_2(t)$ and $m(t)$ must be close to the catalogue compilation date. In fig. 7.40 one sees the function graphs of $m_2(t)$ and $m(t)$ for a configuration of 8 named stars of the Almagest, and the same graphs for a configuration of 6 named stars in fig. 7.41.

It is obvious that in both cases we see a distinct minimum point that falls upon $t = 14$ (500 A.D.). In both cases the minimal value of $m(t)$ is roughly equivalent to 14', which corresponds to the average precision rate of 10' for every coordinate. The dating of 500 A.D. is very clearly located at a considerable distance from the Scaligerian dating of the Almagest's compilation.

The fact that the dating we end up with, or 500 A.D., is more ancient as compared to the dating interval calculated above with the aid of latitudinal analysis is explained by the fact that the longitudinal error taken independently from the latitudes assumes a minimal value at $t \approx 31$, or 1200 B.C., qv in section 9. Dating the Almagest to 1200 B.C. obviously makes no sense at all. However, one has to bear in mind that the minimum of the average longitudinal discrepancy is manifest very poorly, therefore the precision rate of this dating might equal several millennia. In

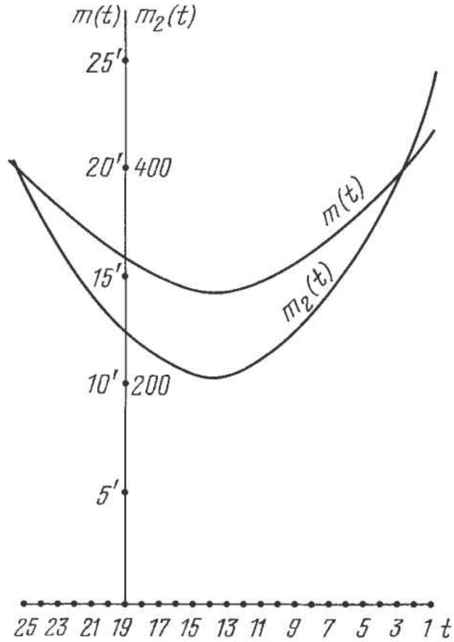


Fig. 7.40. Graphs $m_2(t)$ and $m(t)$ that characterise the varying configuration of 8 named Almagest stars.

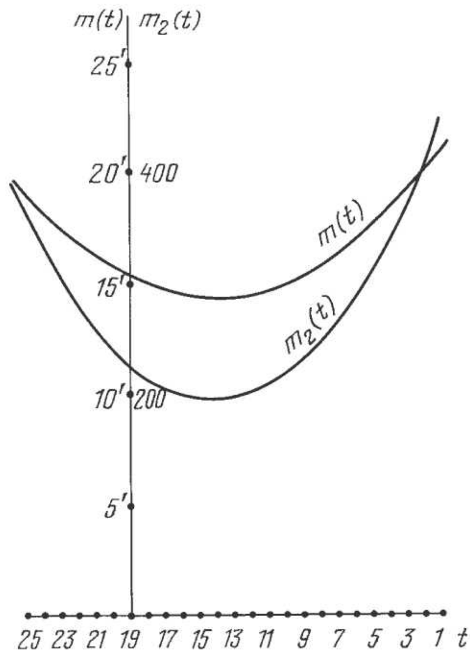


Fig. 7.41. Graphs $m_2(t)$ and $m(t)$ that characterise the altering configuration of 6 named Almagest stars.

other words, it contradicts nothing, qv in figs. 7.38 and 7.39. The minimum of the latitudinal discrepancy, on the other hand, happens to fall on $t = 10$, or 900 A.D., and is a great deal more obvious. This results in the minimum of mean-square arc aberrations falling over the intermediate point $t = 14$, or approximately 500 A.D. This dating is a lot closer to the latitudinal minimum point than to the longitudinal.

11. CONCLUSIONS

1) The dating of the Almagest catalogue estimated with the statistical and the geometrical procedures that we suggest is located on the interval between 600 A.D. and 1300 A.D.

2) A pre-600 A.D. dating gives us no opportunity to make the real celestial sphere concur with the Almagest star atlas, with latitudinal discrepancies of all the stars comprising the informative kernel of the Almagest remaining under the 10" threshold.

3) Even if we are to assume the Almagest catalogue's precision to equal 15' and not 10', the Scaligerian epoch of Ptolemy (I-II century A.D.) remains outside the possible dating interval.

4) Changing the contingent of the Almagest's informative kernel also does not lead to the inclusion of Ptolemy's lifetime in its Scaligerian version into the possible dating interval.

5) Real errors in the manufacture of astronomical instruments leading to non-linear distortions of the celestial sphere in the catalogue can still neither shift nor widen the dating interval enough for the latter to include the Scaligerian epoch of Ptolemy.

CHAPTER 8

Tilt angle between the ecliptic and the equator in the Almagest

1. PTOLEMY'S CONCEPT OF THE ECLIPTIC TILT ANGLE VALUE AND SYSTEMATIC ERROR γ

Tilt angle $\varepsilon(t)$ between the ecliptic and the equator is one of the most important values in astronomy. It is necessary to know this angle in order to estimate the ecliptic coordinates of the stars, regardless of the exact method used for said estimation. One can use the astrolabe, as the Almagest text suggests, or use special cosmospheres for conversion from equatorial coordinates, as it was done in the Middle Ages. Other methods counld also have been used, qv in Chapter 2 and the Introduction. It is presently known that the angle of $\varepsilon(t)$ varies over the course of time according to the following rule:

$$\varepsilon(t) = 23°27'8.2849" + 46.8093"t + 0.0059"t^2 - 0.00183"t^3,$$

where t stands for time counted in centuries backwards from 1900 A.D. (see formula 1.5.3).

The text of the Almagest contains detailed descriptions of how angle ε should be measured, and also the actual instruments that were used for this purpose, qv in Chapter I.12 of the Almagest ([1358]). It is claimed that these measurements resulted in the calculation of the 2ε value that equalled 11/83 of a full circle, or, in modern terms, $\varepsilon_A = 23°51'20"$. Here the value of ε_A stands for the value of angle ε known to the author of the Almagest.

When the author of the Almagest was compiling the star catalogue, he must have used a known value of angle ε, recording it with his instrument (astrolabe, cosmosphere etc). The error in the estimation of the real ε value made by the author of the catalogue would result in the entire celestial sphere as a whole shifted by a certain angle equal to the rate of this error. In other words, the error made in the representation of angle ε on the astronomical instrument leads to a systematic error inherent in the coordinates of all the stars in the catalogue – or, more specifically, the part of the catalogue that was measured with this instrument. It is easy enough to understand that a systematic error of this sort would primarily affect the latitudes of the stars. It is this very systematic error that we educed in Chapter 6 when we were trying to calculate $\gamma_{stat}(t)$ for different values of t. The temporal dependency of the error is primarily defined by the true value of angle $\varepsilon(t)$ changing gradually over the course of time. This alteration is uniform and virtually linear within the confines of the a priori chosen time interval $0 \le t \le 25$.

When the author of the Almagest star catalogue made a mistake in the determination and the fixation

of angle ε with his instrument, he altered the value of ε, making it either greater or smaller than the real value; the catalogue would thus either gain or lose age according to the tilt of the ecliptic to the equator. Any of these possibilities could become a reality with the probability of 0.5. What we observe de facto is a manifestation of the most likely option, namely, the value of ε as represented by the Almagest catalogue equals the real value of $\varepsilon(t)$ for the approximate epoch of 1200 B.C., qv in Chapter 6. The compiler of the Almagest had thus made the star catalogue a great deal older.

Let us assume that the Almagest catalogue was compiled in time moment *t* and that its author considered the tilt angle between the ecliptic and the equator to equal 23°51'20", which is the value stated in the Almagest. Let us also assume that the compiler of the catalogue tried to fix this value of the angle on his astronomical instrument designed for the estimation (via direct observation or re-calculation) of ecliptic stellar coordinates. If we are to consider that the observer's error value lies within the allowed range $\pm\Delta\varepsilon$ defined by the instrument manufacture precision, the summary error of angle ε as fixed by the instrument would equal

$$\varepsilon_A - \varepsilon(t) \pm \Delta\varepsilon = 23°51'20" - \varepsilon(t) \pm \Delta(\varepsilon).$$

Let us compare the value of this error with the confidence strip $\gamma_{stat}(t) \pm \Delta\gamma$ of systematic error γ as well as the set of γ for which it is possible to superimpose the stellar configuration of the Almagest's informative kernel with the corresponding calculated stellar configuration, and with guaranteed latitudinal precision rate equalling 10', qv in Chapter 7, which also tells us that the last set is non-empty for all intervals but $6 \leq t \leq 13$. Let us choose the values estimated by celestial area *Zod A* for $\gamma_{stat}(t)$ since, as it has been stated above, Almagest catalogue part *Zod A* possesses a single systematic error γ. The confidence strip of γ is more narrow for this part of the catalogue; furthermore, all the stars of the informative kernel are either located in *Zod A* or its immediate vicinity, qv in Chapter 7.

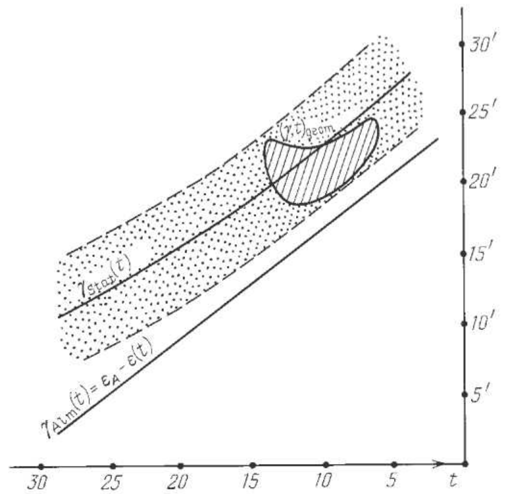


Fig. 8.1. Confidence strip $\gamma_{stat}(t) \pm \Delta\gamma$ estimated for *Zod A*: the set of possible $\gamma_{geom}(t)$ values for the geometrical dating procedure, as well as the dependency graph for the deviation $\varepsilon = \varepsilon_A$, as indicated in the Almagest and the true value of this angle.

In fig. 8.1 we see the confidence strip $\gamma_{stat}(t) \pm \Delta\gamma$ estimated by celestial area *Zod A* with a confidence level of 0.998. We also see the set of acceptable $\gamma_{geom}(t)$ geometrical dating procedure values for which the maximal latitudinal discrepancy of the Almagest informative kernel stars does not exceed 10', qv in Chapter 7. Finally, in fig. 8.1 we see a dependency graph for the aberration of $\varepsilon = \varepsilon_A$ as given in the Almagest from the real value of this angle: $\gamma_{Alm}(t) = \varepsilon_A - \varepsilon(t)$.

	Arc length (ring length) in millimetres depending on the ring radius in metres		
Arc	*0.5 (3.14)*	*0.75 (4.71)*	*1.0 (6.28)*
2'30"	0.4	0.5	0.7
5'	0.7	1.1	1.4
10'	1.5	2.2	2.9
1°	8.7	13.0	17.5

Table 8.1. Arc lengths of 2.5', 5', 10' and 1° in millimetres as indicated on the rings whose radius equals 50 cm, 75 cm and 1 m.

Fig. 8.1 demonstrates that the graph of $\gamma_{Alm}(t)$ to be in close propinquity with the "geometrically valid" area $(\gamma, t)_{geom}$ and the confidence strip that surrounds $\gamma_{stat}(t)$, albeit not crossing it – the latter would take place if we transposed the graph of $\gamma_{Alm}(t)$ upwards by circa 2.5'. Then it shall automatically begin to cross both the confidence strip and the "geometrically valid" area shifted towards the respective edge of the confidence strip. A shift of 6.5' upwards shall make the graph of $\gamma_{Alm}(t)$ virtually coincide with the graph of $\gamma_{stat}(t)$, while still crossing the "geometrically valid" area. The value of the shift needed for this purpose corresponds to the allowed variation of $\Delta\varepsilon$ with ε_A fixed on the instrument and gives us an idea of just how precise the manufacturers of the astronomical instrument could have been. Table 8.1 contains the arc length values of 2.5', 5', 10' and 1° (in mm) on an astronomical instrument (astrolabe, cosmosphere etc) with a radius of 50 cm, 75 cm and 1 m.

From table 8.1 we can see that for the ε angle fixation error $\Delta\varepsilon$ of an astronomical instrument, the value of 2.5'-5' is very real for the Middle Ages. It corresponds to the linear size fluctuation range of a mere 0.5-1 mm.

Thus, the ecliptic tilt values that we have discovered in the Almagest catalogue correspond with the value of ε_A contained in the text of the Almagest.

2. THE PETERS ZODIAC AND THE SINE CURVE OF PETERS

Paragraph 1. The book of Peters and Knobel ([1339]) contains an important discrepancy graph that Peters obtained from his analysis of the Almagest catalogue. The sine curve of this graph shall be referred to as the "latitudinal sine curve of Peters" (see [1339], page 6). This curve indicates the present of certain systematic errors in the Almagest.

In the present section we shall explain why the "sine curve of Peters" is inherent in the Almagest catalogue.

Paragraph 2. Let us consider the location of the ecliptic $\prod$ for $t = 18$, or 100 A.D. We shall mark the vernal equinox point $Q(18)$ upon it. We shall proceed to divide the ecliptic into 360 degrees, using the vernal equinox point for initial reference, qv in fig. 8.2.

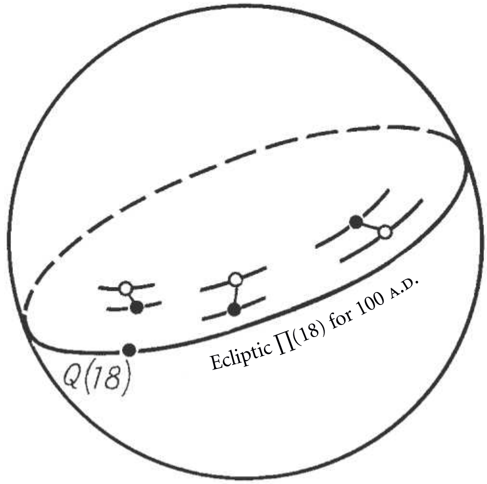


Fig. 8.2. Position comparison for real stars in 100 A.D. and their positions as indicated in the Almagest.

Now let us mark the positions of the real stars for 100 A.D. as black dots on the celestial sphere, and the positions of the same stars in the Almagest as white dots. Respective dot pairs (black and white) are linked together with segments in fig. 8.2, so as to make the correspondences clear.

We can calculate the latitudinal difference for each such pair, or the latitudinal discrepancy in other words. We are thus calculating the difference between the latitude of star i in the Almagest and the real latitude of this star for 100 A.D. Peters studies the Zodiacal stars of the Almagest from this position in [1339]. However, he appears to have missed some of them. The Almagest contains a total of 350 Zodiacal stars. As we point out in [1339], page 17, Peters only chose 218 stars for his study of the Zodiacal star longitudes, without specifying the selection principles. The exact amount of stars studied by Peters in his research of he latitudes isn't given anywhere in [1339], but one can assume him to have take the same stars as he did in his research of the longitudes.

Let us calculate latitudinal discrepancies for all the stars from the zodiacal list and represent them on the graph. This shall require taking the longitude of the stars and marking it on the horizontal axis, and then presenting the value of the latitudinal discrepancy on the vertical. This shall result in a certain agglomeration of points drawn on the plane which we

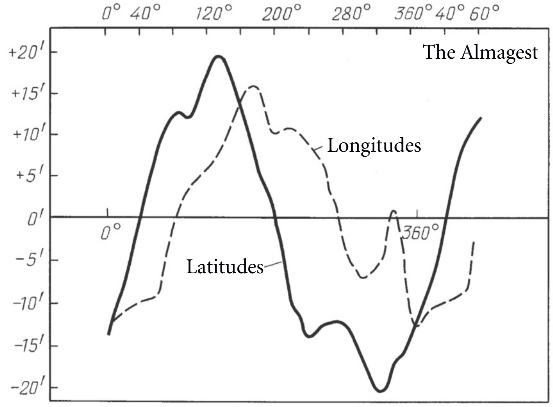


Fig. 8.3. The smoothing curves of Peters for 100 A.D. (latitudinal and longitudinal).

shall be referring to as the "error field". Once we divide the longitudinal scale into 10-degree segments and average each one of those, we can build the smoothing curve as seen in fig. 8.3. This curve, in turn, can be approximated by the optimal sine curve according to the minimal criterion of the mean-square discrepancy.

A similar procedure can be performed for the longitudes. We shall come up with another smoothing curve as a result which is represented in fig. 8.3 as a dotted curve. We shall talk about this curve later.

Let us find a natural explanation of these curves.

Paragraph 3. Let us begin with a study of the latitudinal sine curve of Peters. We must note that the natural mechanism that allows us to explain the inclusion of systematic errors into the latitudes of Zodiacal stars. This is the error in the location of the observer's ecliptic plane as compared to that of the real ecliptic for the moment of observation which isn't known to us a priori.

Let us return to our consideration of ecliptic $\prod(t_0)$ for observation moment t_0. Equinox point $Q(t_0)$ is marked in fig. 8.4 as the beginning of coordinates. Above we see the latitudinal error field for $t = 18$. Let us do the same for the Almagest catalogue star observation moment t_0 and draw the corresponding latitudinal error field in fig. 8.5. The smoothing curve shall be marked $c(X, K(t_0, 0, 0)$ – see the dotted curve in fig. 8.5. Let us explain this indication. As above, X is used for referring to the Almagest catalogue. $K(t, \beta, \gamma)$ is used for referring to the real catalogue $K(t)$ referring to real star positions for epoch t perturbed by parameters β and γ, qv in Chapter 6. Thus, $K(t_0, 0, 0)$ is a catalogue which was not subject to random perturbation that shows real star positions for observation moment t_0 that we do not know a priori.

We already explained it in Chapter 6 that in order to find the optimal ecliptic rotation in the square average sense, we have to solve the correspondent regression problem. For this end we shall have to use a two-parameter sinusoidal family as the family of ap-

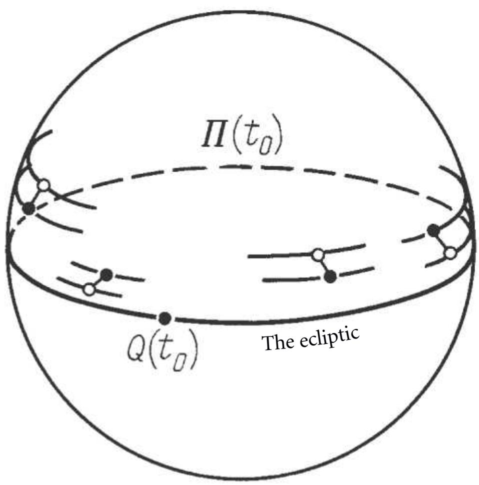


Fig. 8.4. The system of accounting for latitudinal errors.

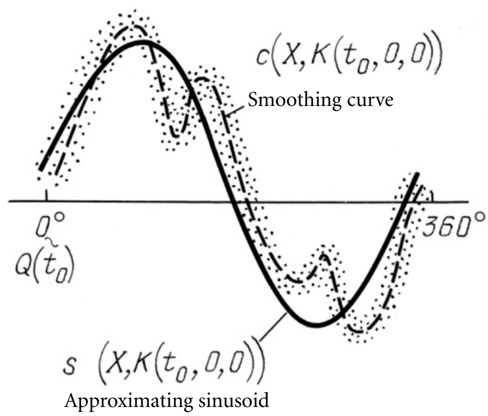


Fig. 8.5. The dotted curve indicates the smoothing curve $c(X, K(t_0, 0, 0)$. The continuous curve is the approximating sinusoid $s(X, K(t_0, 0, 0)$.

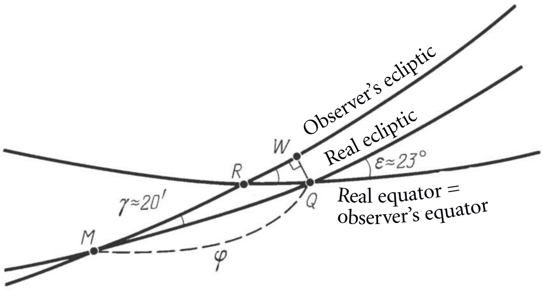


Fig. 8.6. The observer's ecliptic, the real ecliptic and the real equator.

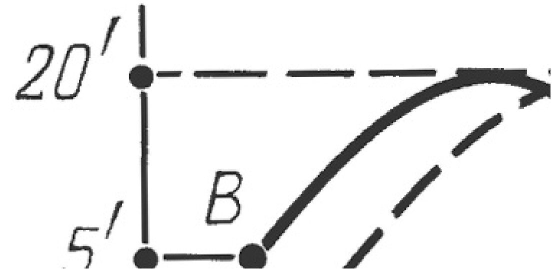


Fig. 8.7. Alteration of the sinusoid phase.

proximating curves. The first parameter of this family shall be defined by the amplitude of a sine curve, and the second – by its phase. We solved this problem in Chapter 6 – for the Almagest in general as well as its different parts in particular; among the latter – the Zodiac which is of interest to us at the moment. Let us define the optimal approximating sine curve as $s(X, K(t, 0, 0))$ – see the continuous curve in fig. 8.5. The parameters of the sine curve shall be defined as A^* (amplitude) and φ^* (phase).

Paragraph 4. It would be a good idea to discuss the concept of approximating sine curve phase. The matter is that the phase is estimated with the precision rate of 15 degrees at best. Let us provide two virtually equivalent explanations to this fact. The first is based on the analysis of how the observer's error in the estimation of the ecliptic plane affects the phase of the approximating sine curve. One sees the following objects in fig. 8.6. Firstly, it is the real equator for observation moment t_0. This equator, as we have explained above, can be considered all but identical with the observer's equator. Secondly, it is the real ecliptic for moment t_0 and the observer's ecliptic.

We know the angle between the observer's ecliptic and the real ecliptic to approximately equal 20', which is the observer's error γ. The angle between the equator and the ecliptic equals ε, or circa 23°. It doesn't matter which one of the ecliptics we are considering at the moment since the angle between them is minute as compared to 23°. The arc in fig. 8.6 represents the observer's error in estimating the vernal equinox point. As we already know, this error is roughly equivalent to 10', which is the scale grading value of the Almagest catalogue. Let us assume arc *RQ* is approximately equal to 10'; in this case arc distance *WQ* shall be approximately equal to 10' × sin20°, or roughly 5'. In this case, arc distance φ, or arc *MQ* from fig. 8.6, shall be equal to circa 5' / sin20', or around 15°. All we have to point out us that arc *MQ* gives us a precise representation of the approximating sine curve phase. We are counting the sine curve phase starting with the vernal equinox point $Q(t)$ upon the real ecliptic $\prod(t)$.

Thus, several-minute perturbations in observer ecliptic estimation perturb the sine curve phase by a factor of several degrees, making the phase "unstable".

The very same phenomenon receives an explanation if regarded as part of the smoothing curve $c(X, K(t, 0, 0))$ approximation problem with the optimal sine curve of $s(X, K(t, 0, 0))$.

Approximating the smoothing curve by the optimal sine curve we reach the minimal value of the possible square average error. One has to allow for a certain variation of this minimum due to the fact that the optimal sine curve's parameters in general fail to concur precisely with the actual observation error. Allowing for 5-minute variations of the square average aberration minimum we must note that a 10-degree phase variation of a sine curve with the amplitude of 20' changes the ordinate of any sine curve point by a maximum of 5'. For a standard sine curve with an amplitude of 1 and a phase of 0 drawn as an continuous curve in fig. 8.7 segment *OA* shall be approximately equal to arc *OB*, since we are presently considering segment *OA* comparatively small, or equalling 1/6 radians (10 degrees). In this case segment *AB* comprises 1/6 of the amplitude, or approximately 3.3'. Therefore, a three-minute perturbation

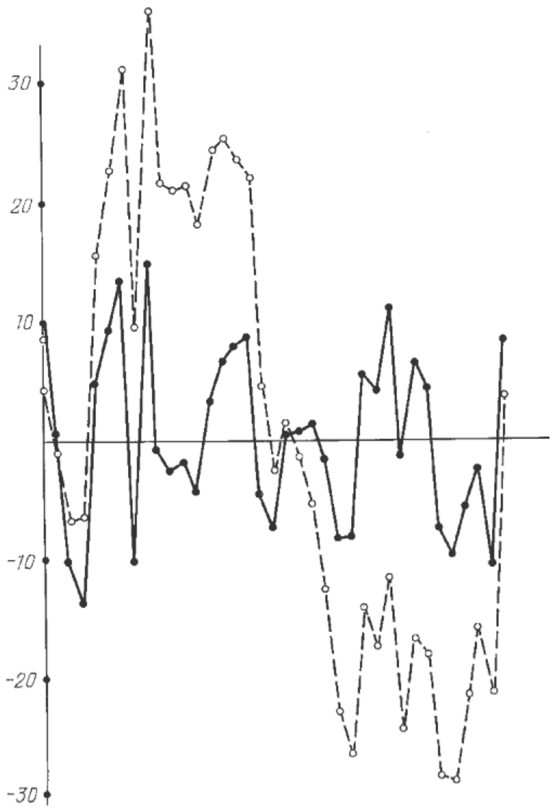


Fig. 8.8. The Almagest, $t = 9$. The dotted curve represents the initial Peters sinusoid, and the continuous curve stands for the same after the subtraction of the systematic error value.

of the square average discrepancy can result in a ten-degree phase alteration of the approximating optimal sine curve.

Paragraph 5. In the preceding chapters we already estimated the possible dating interval of the Almagest catalogue, namely, we discovered that t_0 lies on the interval between 6 and 13, or approximately 600 A.D. and 1300 A.D. Therefore it would be particularly interesting if we studied the approximating sine curves $s(X, K(t, 0, 0))$ for this very interval of possible datings. It turns out that they don't alter too much inside the interval between 600 A.D. and 1300 A.D., or prove to be poorly-dependent on t_0. More precisely, the maximal amplitude of A^* changes from 26' for $t_0 = 6$ to 20' for $t_0 = 13$ inside the interval between 600 A.D. and 1300 A.D. The corresponding phase shifts of φ^* take place between the values of –17° and –18° in relation to the corresponding equinox point $Q(t_0)$ on the ecliptic $\prod(t_0)$. We can therefore regard any smoothing curve $c(X, K(t_0, 0, 0))$ as a "typical representative" of the class, where t_0 can assume any value from 6 to 13. It would be natural to consider the middle of the time interval, namely, the value of $t_0 = 9$.

Let us demonstrate how the smoothing curve $c(X, K(t_0, 0, 0))$ looks at $t_0 = 9$ before and after the optimal sine curve subtraction, or, in other words, before and after the exclusion of the systematic errors that we discovered. In fig. 8.8 one sees that the smoothing curve $c(X, K(t_0, 0, 0))$ is close to a sine curve for $t_0 = 9$. The parameters of the optimal sine curve for $t_0 = 9$ are as follows: the amplitude equals to 24', and the phase to –17°. The smoothing curve is drawn as a dotted curve in fig. 8.8. Excluding observer's ecliptic estimation error from catalogue X is equivalent to subtracting the optimal sine curves with the parameters being $A^* = 24'$ and $\varphi^* = -17°$ for $t_0 = 9$. As a result, the latitudinal discrepancy smoothing curve assumes the form drawn as a continuous curve in fig. 8.8. One can clearly see the difference between the dotted curve and the continuous curve; the latter fluctuates around the abscissa axis and corresponds to the zero average error of the observer in the estimation of the ecliptic position. It is obvious that the error field is now approximated by a degenerate sine curve, or a mere straight line that becomes superimposed over the abscissa.

Conclusion. The compensation of observer errors on the discovered possible dating interval of the Almagest catalogue, namely, 600-1300 A.D., results in the disappearance of such effects as the latitudinal sine curves of Peters.

Paragraph 6. Let us return to the sine curve of Peters in the latitudes of the Almagest catalogue. Since it is possible that Peters did not account for all of the Zodiacal stars in his calculations, we have re-calculated and built a graph similar to that of Peters for $t = 18$, or 100 A.D., qv in fig. 8.3. We have considered all the Zodiacal stars of the Almagest except for several rejects with a latitudinal discrepancy of more than 1.5°. The data were taken from [1339]. We processed nearly all of 350 Zodiacal Almagest stars.

The result of our calculations can be seen in figs. 8.9 and 8.10 together with the latitudinal error field of the Almagest Zodiac for $t = 18$. This field consists

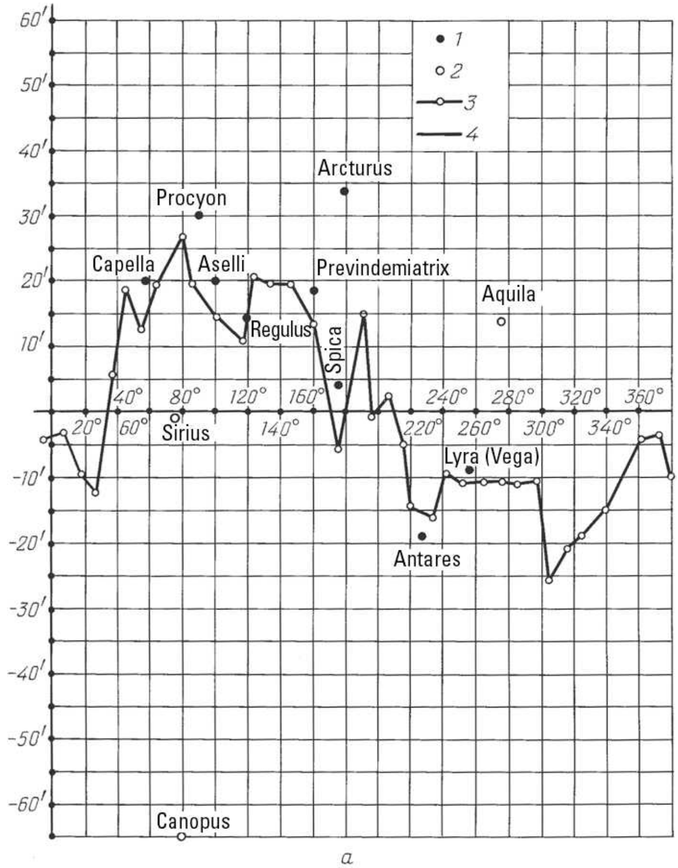


Fig. 8.9. The Peters curve that we calculated for the Almagest zodiac, $t = 18$.

of 350 points scattered across a plane. The continuous zigzag represents the smoothing curve $c(X, K(t_0, 0, 0))$. It is plainly visible that it bears qualitative semblance to the curve of Peters in fig. 8.3. In general, the behaviour of our adjusted curve in fig. 8.9 is similar to that of the Peters curve in fig. 8.3. However, there are some minor differences which are apparently explained by Zodiacal star selection principle used by Peters which remains unknown to us.

In fig. 8.10 one also sees the optimal sine curve $s(X, K(18, 0, 0))$. Its parameters are as follows: an amplitude of 16' and a phase of –22°, qv in Chapter 6.

Paragraph 7. Above we have considered various properties of the latitudinal error field as related to the real observation moment t_0. Let us now examine the same field for the arbitrary moment t which does not coincide with t_0. We see the following in fig. 8.11:

1) The real ecliptic $\prod(t)$ for observation moment t_0.

2) Observer ecliptic represented by a dotted curve and not equal to $\prod(t_0)$ due to the effects of the observation error made by the Almagest catalogue compiler.

3) The real ecliptic $\prod(t)$ for any other fixed moment t.

Vernal equinox points $Q(t_0)$ and $Q(t)$ are drawn on the ecliptics $\prod(t_0)$ and $\prod(t)$. Point N corresponds to the crossing of said ecliptics. The distance between point M and ecliptic $\prod(t)$ is rather small, that is to say, it doesn't exceed 20' if $|t - t_0|$ does not exceed 2000 years. Therefore, the latitudinal error field as related to ecliptic $\prod(t)$ should be approximated as a sum of two sine curves. The first results from observation error made in time moment t_0 and was discussed in detail above. The phase of this sine curve

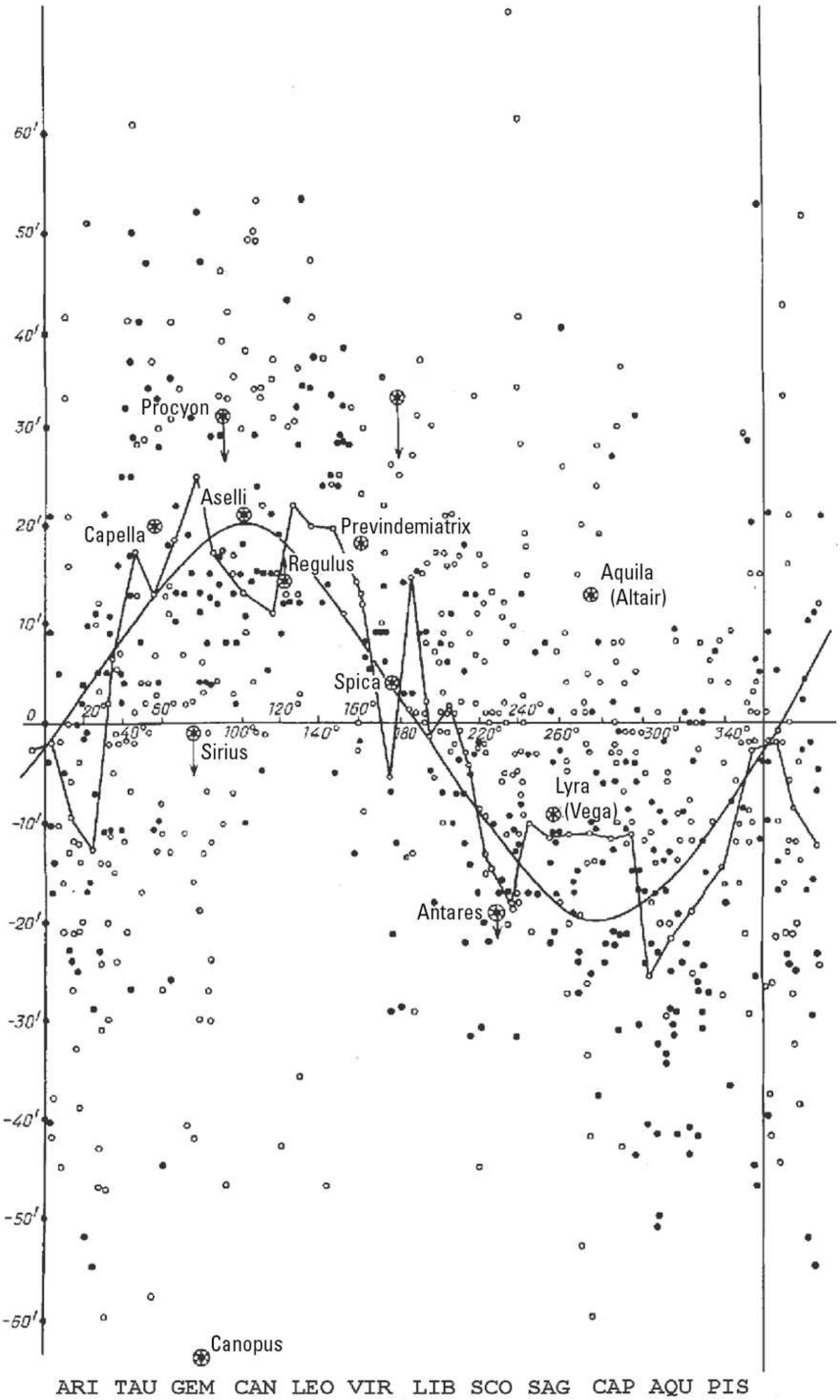


Fig. 8.10. Error field for the Almagest zodiac, $t = 18$. Zodiacal stars are represented by black dots, others – by light ones. The zigzag is the Peters curve approximated by 10-degree intervals, whereas the smooth curve stands for the optimal sinusoid.

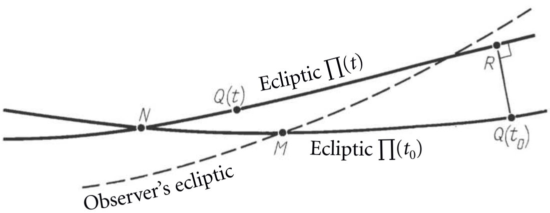


Fig. 8.11. The real ecliptic for the moment of observation, the observer's ecliptic and the position of the real ecliptic for a different moment in time.

as related to vernal equinox point $Q(t)$ on ecliptic $\prod(t)$ approximately equals the sum of its phase as related to vernal equinox point $Q(t_0)$ – see arc $MQ(t_0)$ in fig 8.11, and the arc distance $RQ(t)$. We are referring to an algebraic sum here, or a sum with either a positive or a negative value. The arc $RQ(t)$ equals the precession value for the time $t - t_0$.

The second sine curve $s_{t,\,t_0}$ represented in fig. 8.12 as a continuous curve, results from the discrepancy between ecliptic $\prod(t)$ and ecliptic $\prod(t_0)$. It has an approximate amplitude of 47" / $|t - t_0|$, qv in [1222] or in Chapter 1. Its phase is estimated by precession formulae from section 5 of Chapter 1 which were taken from [1222] originally.

The resultant approximating curve represents the sum of these two sine curves. This curve has a single local maximum and a single local minimum upon the circumference, or the ecliptic.

This implies the following simple statement. Let us regard the two time moments of t_0 and t. Then the smoothing curve $c(X, K(t_0, 0, 0))$ shall approximately coincide with the sum of the two curves $c(X, K(t, 0, 0)) \approx c(X, K(t_0, 0, 0)) + s_{t,\,t_0}$. Thus we can claim that a sine curve like that of Peters for time moment t approximates the sum of a similar sine curve for moment t_0 and the one corresponding to the rotation of the ecliptic over the time $t - t_0$ (between t_0 and t). This is a general statement valid for all couples of t and t_0.

Paragraph 8. Now let us consider the resultant approximating curve for 100 A.D., or $t = 18$. We have just explained that one needs to add up two sine curves for this purpose. The first corresponds to the real observation moment t_0, and the second to time moment t for which the resultant approximating curve is calculated. Let us choose $t_0 = 9$ as the "real observation time", or roughly 1000 A.D. This value of t_0 is the middle of the possible Almagest catalogue dating interval between 600 and 1300 A.D., or $t = 13$ and $t = 6$, that we have discovered. The first sine curve (see the dotted curve in fig 8.13) has the amplitude of 24' and the phase of –5°, which is a sum of –17° (see arc $MQ(t_0)$ in fig. 8.11), and 12°, of the precession for some 900 years.

The second sine curve (see the fine continuous curve in fig. 8.13) corresponds to the choice of the moment $t = 18$, or 100 A.D., qv above. Its amplitude roughly equals 47" × 9 ≈ 7', qv above, and its phase approximates 160°, qv in Chapter 1. On the fragment between –20° and 160° as seen in fig. 8.13 this curve is located under the abscissa, or has a negative value. Adding up the two sine curves we shall get the resultant approximating curve drawn as a bold continuous curve in fig. 8.13.

Thus, the latitudinal discrepancy sine curve dis-

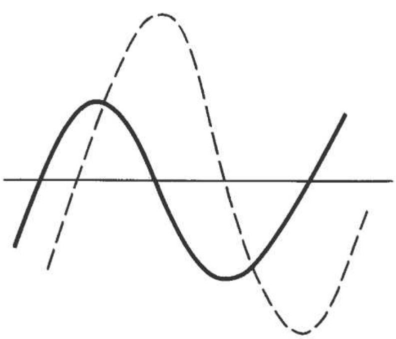


Fig. 8.12. A pair of sine curves whose sum roughly defines the latitudinal error field.

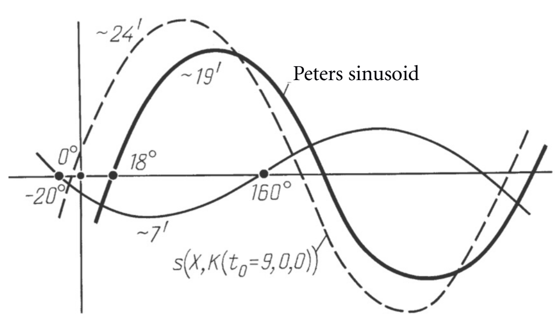


Fig. 8.13. A sum of two sinusoids yields a Peters sinusoid (bold curve).

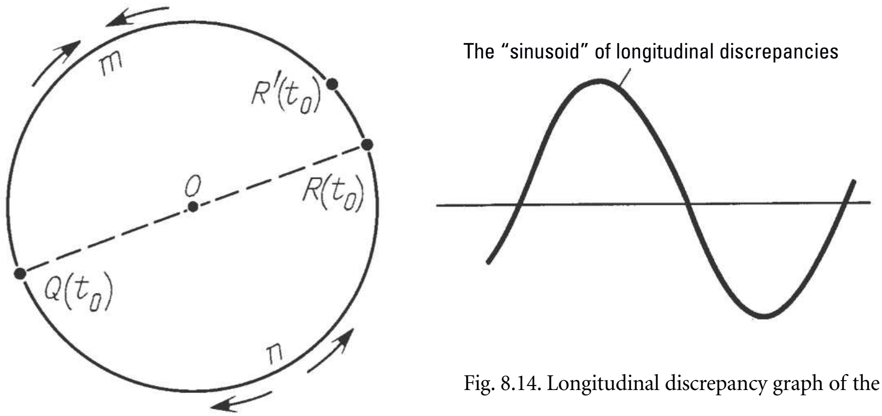


Fig. 8.14. Longitudinal discrepancy graph of the zodiacal stars.

covered by Peters under the assumption that the Almagest catalogue was compiled in 100 A.D. is a sum of two sine curves, namely, the observation moment sine curve resulting from the incorrect estimation of the ecliptic position by the observer, and the sine curve that results from the angle between the ecliptic of 100 A.D. and the ecliptic of the observation time.

Paragraph 9. Let us conclude with turning to the longitudinal sine curve of Peters (see the dotted curve in fig. 8.3). The mechanism described above explains the genesis of the latitudinal sine curve; however, it hardly affects the longitudes of the Zodiacal stars. Therefore, the incorrect estimation of the ecliptic by the observer does not result in a manifest longitudinal sine curve. Nevertheless, we can witness a weakly-manifest sine curve to appear in longitudes as well. Let us assume that the mediaeval observer made an error in his estimation of the vernal and autumnal equinox points, or, which is virtually the same, measured the coordinates of the basis stars with insufficient precision. Bear in mind that unlike the latitudes that were always counted from the ecliptic ring of the astronomical instrument, fixed in its construction with a permanent error, stellar longitudes were counted off several bright basis stars. Otherwise one would have to measure angles larger than 180°, which is an arduous procedure (see Chapters VII.3 and VII.4 of the Almagest ([1358])). This circumstance is illustrated in fig. 8.14.

Lack of precision in the estimation of the equinox points by the observer shall lead to a de facto division of the ecliptic into two unequal parts by the points $Q(t_0)$ and $R'(t_0)$. Here $R'(t_0)$ stands for the erroneous position of the autumn equinox point and $R(t_0)$ being the real autumn equinox point. The length of arc RR' may be rather small, around 10' – 15', remaining within the precision threshold of the Almagest. Some of the Zodiacal longitudes could be measured from the vernal equinox point Q, or a certain group of basis stars, whereas other longitudes would be measured from the autumn equinox point R, or from another group of basis stars. As a result, stellar longitudes on segment QmR' shall be "compressed" by roughly 15', whereas on segment QnR' they shall, on the contrary, be expanded by roughly 15'. Therefore, calculating the longitudinal discrepancy graph of the Zodiacal stars, we shall end up with a sinusoidal curve, qv in fig. 8.14. Bear in mind the relatively small value of the 10' – 15' error, which is the amplitude of the longitudinal Peters sine curve as seen in fig. 8.3.

CHAPTER 9

The application of our method to the dating of other mediaeval catalogues

1. INTRODUCTION

Above we have described the methods of statistical analysis and dating of stellar catalogues and applied it to the Almagest star catalogue. It would be of interest to apply the very same method to the dating of other catalogues compiled with the aid of instruments similar to Ptolemy's, or naked eye observations.

The present chapter contains a study of the star catalogues compiled by Ulugbek, Al-Sufi, Tycho Brache and Hevelius. The catalogue of Al-Sufi turned out to be a mere clone of the Almagest. However, several observers already pointed this out – see [1339], [1119] and [1120], for instance. We are apparently the first to have conducted an in-depth statistical analysis of stellar latitude errors in the catalogues of Ulugbek, Tycho Brahe and Hevelius. The precision of these catalogues turned out a great deal worse than it was believed, qv below. The discrepancy is the greatest for the catalogue of Hevelius – a factor of 100x or 200x, no less.

We first dated the catalogues of Tycho Brahe and Ulugbek. The dating of Tycho Brahe's observations is presumed to be well-known – 1570-1600 A.D. Our method yields a dating of Tycho Brahe's catalogue that concurs with this period quite well.

In case of Ulugbek's catalogue, the possible interval that we calculated also covers the Scaligerian dating of its compilation, namely, 1437 A.D. However, this interval also intersects with the above possible dating interval as calculated for the Almagest catalogue. What we should point out in this respect is that the precision of both Ptolemy's catalogue and Ulugbek's is virtually the same; therefore, it is possible that their catalogues were indeed compiled around the same time.

2. TYCHO BRAHE'S CATALOGUE

2.1. A general characteristic of Tycho Brahe's catalogue and the result of our dating

The edition of Tycho Brahe's catalogue that we chose for research had originally been Kepler's and dates to 1628; it was subsequently reprinted in [1024]. Tycho Brahe's catalogue is rendered to the epoch of 1600 A.D. by longitudinal precession in this edition. The structure of the catalogue coincides with that of the Almagest as well as the order in which the constellations are listed – with the exception of several constellations from the very end of the Almagest catalogue which aren't present in the work of Tycho Brahe. There are 1005 stars altogether in Tycho

Brahe's catalogue. The construction principle of the instruments used by Tycho Brahe is the same as of those described by Ptolemy. Therefore, despite the numerous improvements, and the highly elolved instrument manufacture procedure, Tycho Brahe's level of precision is comparable to that of the Almagest catalogue, albeit somewhat better. It equals 2'-3' as opposed to the 10'-15' of the Almagest. The drastic leap in astronomical observations appears to have taken place somewhat later, after the invention of the telescope.

The dating of Tycho Brahe's observations is assumed to be known very well – namely, 1570-1600. Dating Tycho's catalogue independently from consensual chronology, using no other data but the stellar coordinates contained in the catalogue, gives us an opportunity of testing the dating method that we suggest using the example of a problem whose solution is known a priori. The resultant dating interval is as follows: 1510-1620 A.D. It has a length of 110 years and covers the time interval of Tycho Brahe's observations. Let us point out that the length of this interval is some 6 times less than what we got for the Almagest (roughly 700 years) using the same method. The reason is that Tycho Brahe's observation precision level is about 5-6 times higher than Ptolemy's.

2.2. The analysis of Tycho Brahe's latitudinal errors and the removal of the "rejects"

In our dating of Tycho Brahe's catalogue we have once again used nothing but stellar latitudes, the reasons being the same as in case of the Almagest. The identifications of Tycho Brahe's catalogue stars on the modern celestial sphere were taken from Bailey's work ([1024]).

It is assumed that Tycho Brahe may have observed only about 800 of the 1005 stars included in his catalogue ([65], page 126). If this is indeed so, the data contained in his catalogue are not of a homogeneous nature. In order to determine what part of Tycho Brahe's catalogue is homogeneous, we have built individual latitudinal error frequency histograms for each of the celestial areas *A, Zod A, B, Zod B, C, D* and *M*. See figs. 9.1-9.7 for results.

Bear in mind that the celestial areas in question have been defined above, in our analysis of the Almagest (see section 3 of Chapter 2). In order to build these histograms we have calculated the ecliptic stellar coordinates for the epoch of 1600 A.D. Then we compared the latitudes of the stars from Tycho Brahe's catalogue with the calculated latitudes of respective stars. In figs. 9.1-9.7 the error rate scale is divided into segments of 0.5' each. This scale is horizontal. What we find on the vertical is the manifestation frequency of a certain error rate.

The resulting histograms demonstrate that among the latitudinal errors in Tycho Brahe's catalogue coordinates we do indeed find rejects. If we are to presume that stellar coordinate measurement errors are distributed normally, which would be a justified expectation, we find that about 15% of error values are located outside the interval 3σ. These values are "rejects". Moreover, we notice that the histograms are shifted towards zero. The approximate value of this shift equals 2' and tells us that Tycho Brahe's catalogue contains a systematic error in stellar latitude with parameter $\gamma \approx 2'$. Remember that values γ and φ, which parameterize the systematic error of the catalogue, were introduced in Chapter 5.

The stars that we excluded from Tycho Brahe's catalogue in the course of reject filtration are the ones whose latitudinal error does not fit into normal distribution. This was done for each of celestial areas *A, B, C, D* and *M* individually. More precisely, we rejected the stars from areas *A, B* and *M* whose latitudinal discrepancy value was more than 5' or less than –7'. All stars with the absolute latitudinal discrepancy value greater than 5' were rejected from area *C*, as well as all area *D* stars with a discrepancy of either more than 4' or less than –3'. The indicated error boundaries have been estimated approximately, judging by figs. 9.1-9.7. We have rejected a total of 187 stars out of 1005. The quantity of the remaining stars (818) is close to 777, which is the amount of stars observed by Tycho Brahe himself, as the legend has it (see [65], page 126).

After the "reject filtering" of Tycho Brahe's catalogue as described above, systematic error parameters $\gamma_{stat}(t)$ and $\varphi_{stat}(t)$ were calculated by the remaining part of the catalogue as functions of presumed dating t. See Chapter 5 for respective definitions. The chosen t alteration interval begins with 1400 A.D., or $t = 5$, and ends with 1700 A.D., or with $t = 2$. The re-

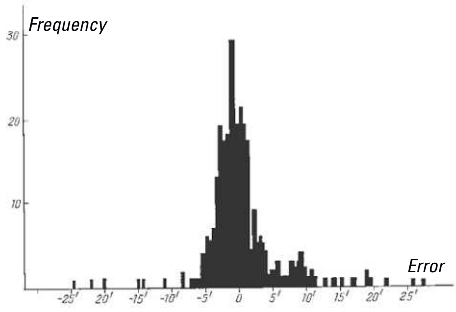


Fig. 9.1. Latitudinal discrepancy histogram for celestial region *A* in Tycho Brahe's catalogue, with $t = 3$.

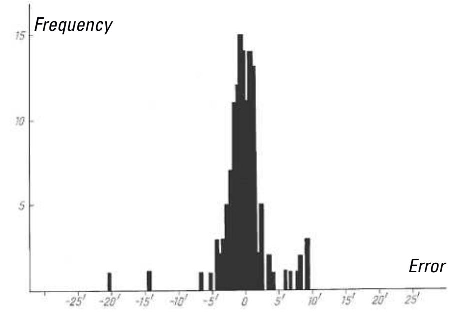


Fig. 9.2. Latitudinal discrepancy histogram for celestial region *Zod A* in Tycho Brahe's catalogue, with $t = 3$.

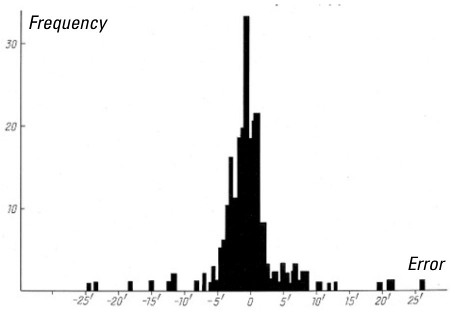


Fig. 9.3. Latitudinal discrepancy histogram for celestial region *B* in Tycho Brahe's catalogue, with $t = 3$.

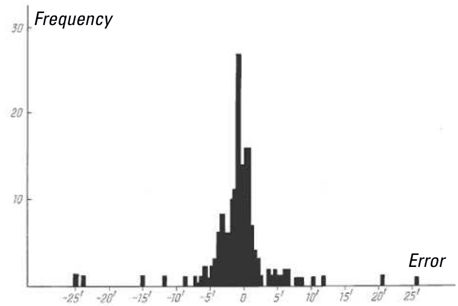


Fig. 9.4. Latitudinal discrepancy histogram for celestial region *Zod B* in Tycho Brahe's catalogue, with $t = 3$.

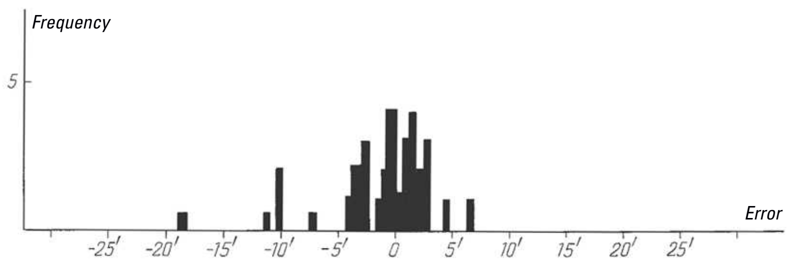


Fig. 9.5. Latitudinal discrepancy histogram for celestial region *C* in Tycho Brahe's catalogue, with $t = 3$.

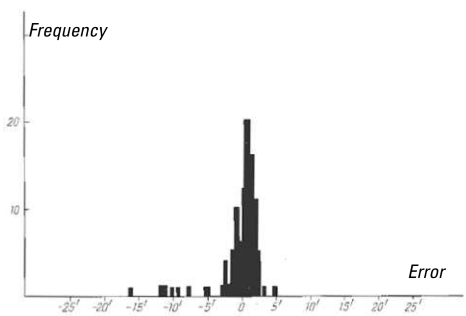


Fig. 9.6. Latitudinal discrepancy histogram for celestial region *D* in Tycho Brahe's catalogue, with $t = 3$.

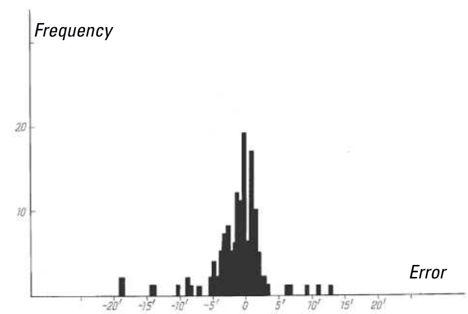


Fig. 9.7. Latitudinal discrepancy histogram for celestial region *M* in Tycho Brahe's catalogue, with $t = 3$.

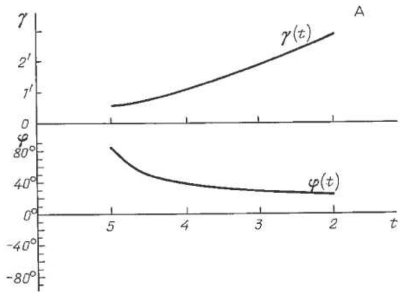


Fig. 9.8. The graphs of $\gamma_{stat}(t)$ and $\varphi_{stat}(t)$ for celestial region *A* in Tycho Brahe's catalogue.

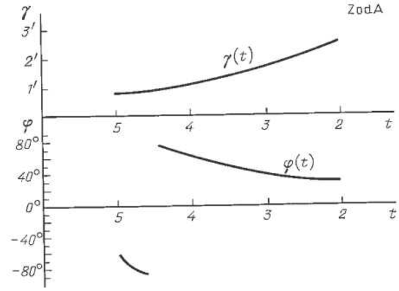


Fig. 9.9. The graphs of $\gamma_{stat}(t)$ and $\varphi_{stat}(t)$ for celestial region *Zod A* in Tycho Brahe's catalogue.

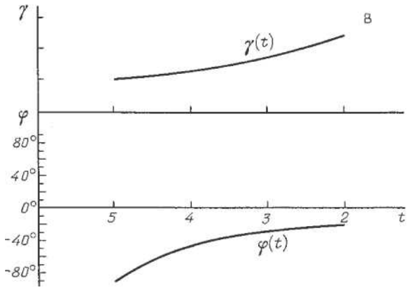


Fig. 9.10. The graphs of $\gamma_{stat}(t)$ and $\varphi_{stat}(t)$ for celestial region *B* in Tycho Brahe's catalogue.

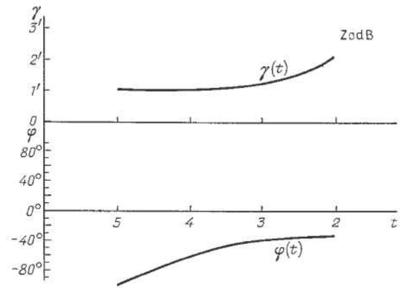


Fig. 9.11. The graphs of $\gamma_{stat}(t)$ and $\varphi_{stat}(t)$ for celestial region *Zod B* in Tycho Brahe's catalogue.

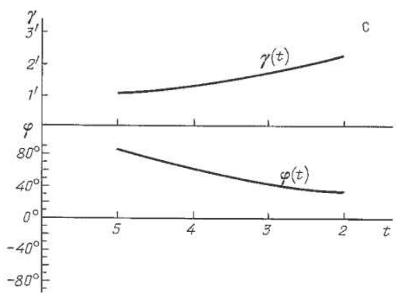


Fig. 9.12. The graphs of $\gamma_{stat}(t)$ and $\varphi_{stat}(t)$ for celestial region *C* in Tycho Brahe's catalogue.

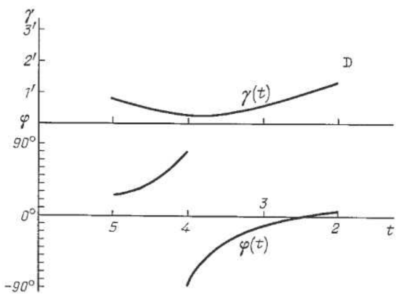


Fig. 9.13. The graphs of $\gamma_{stat}(t)$ and $\varphi_{stat}(t)$ for celestial region *D* in Tycho Brahe's catalogue.

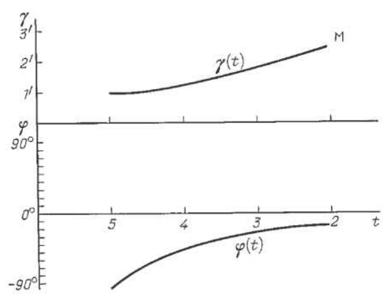


Fig. 9.14. The graphs of $\gamma_{stat}(t)$ and $\varphi_{stat}(t)$ for celestial region *M* in Tycho Brahe's catalogue.

sult of calculating the functions of $\gamma_{stat}(t)$ and $\varphi_{stat}(t)$ for each of the seven celestial regions (see section 2 of Chapter 6) is represented graphically in figs. 9.8-9.14. The graphs clearly demonstrate that parameter φ assumes substantially different values for different celestial areas in Tycho Brahe's catalogue, and doesn't appear to represent a systematic error. Parameter γ, on the other hand, behaves in the exact same manner for every celestial region.

A propos, we observed a similar situation in our analysis of the Almagest catalogue, qv in Chapter 6. The $\gamma_{stat}(t)$ graphs for celestial regions *A, Zod A, B, Zod B, C* and *M* from Tycho Brahe's catalogue resemble each other, qv in figs. 9.8-9.14. Celestial area *D* is the only exception here – parameter γ behaves differently for this area, qv in fig. 9.13. Therefore we rejected the stars from celestial region *D* in our dating of Tycho Brahe's observations.

2.3. The choice of the informative kernel for Tycho Brahe's catalogue

According to the astronomical observation dating algorithm that we suggest, we have to choose the informative kernel of Tycho Brahe's catalogue. As it is pointed out in [643] (see section 8 of the Introduction to [643]), Tycho Brahe chose 21 basis stars in the vicinity of the Zodiac, having estimated the equatorial coordinates of these stars with maximal possible precision. He would then convert them into ecliptic coordinates. The list of such stars was borrowed from [1049] (see table 9.1).

For constellations that contain stars from this list we have found group errors $\gamma^{G}_{stat}(t)$ and $\varphi^{G}_{stat}(t)$ for $t = 3$. See section 3 of Chapter 6 for definitions of these values. The stars from constellations whose group error $\gamma^{G}_{stat}(t)$ differed from $\gamma^{ZodA}_{stat}(t)$ by more than 2' for $t = 3$ were excluded from further consideration. For the remaining constellations we calculated the percentage of stars whose latitudinal error does nor exceed 1', 2' and 3' respectively for $t = 3$. We have then calculated the square average latitudinal discrepancy for each constellation – both disregarding and considering the systematic error, with parameters $\gamma = \gamma^{G}_{stat}(t)$ and $\varphi = \varphi^{G}_{stat}(t)$ for $t = 3$. The same parameters were calculated after the compensation of the common systematic error with parameters $\gamma = \gamma^{ZodA}_{stat}(3) = 1.8'$, $\varphi = 0$. It turns out that the compensation of the common systematic error leads us to the same result as the compensation of the group error for each of the constellations considered, qv in table 9.2. Now we can consider the systematic error to be *common* for the group of constellations that we have under study and use the values of $\gamma = \gamma^{ZodA}_{stat}(t)$, $\varphi = 0$.

We included 12 stars out of 21 into the informative kernel of Tycho Brahe's catalogue – the ones that remained in the catalogue after the "group error filtering" as described above. Apart from that, we included two fast and bright named stars into it – Arcturus = α Boo and Procyon = α CMi. The third fast named star (Sirius) was not included in the informative kernel, since it is located in celestial region *D* that possesses a unique systematic error, qv above. Therefore, the informative kernel of Tycho Brahe's catalogue consists of 14 stars:

γ Ari, α Ari = Hamal, ε Tau, α Tau = Aldebaran, γ Can = Aselli, γ Leo, α Leo = Regulus, γ Vir, α Vir = Spica, Δ Oph, α Aqu, α Pis, α Boo = Arcturus and α CMi = Procyon.

2.4. The dating of Tycho Brahe's observations

As it is implied by table 9.2, the residual square average latitudinal error after the compensation of the systematic compound with parameters $\gamma = \gamma^{ZodA}_{stat}(t)$, $\varphi = 0$ fluctuates within the boundaries of 1'-3' for the constellations that contain informative kernel stars. The percentage of stars in constellations whose latitudinal error is less than 2' is greater than 50% in all cases.

According to the dating interval suggested in Chapter 7, one has to take 2' as the Δ threshold. Then one would have to determine the time interval for which the latitudinal discrepancy of all the informative kernel stars does not exceed $\Delta = 2'$. The resultant interval shall contain possible datings of Tycho Brahe's observations.

We calculated this time interval. It begins with 1510 A.D. and ends in 1620 A.D. ($2.8 \le t \le 3.9$). We use a 10-year step for Tycho Brahe's catalogue. Here, as above, presumed catalogue dating *t* is measured in centuries and counted backwards from 1900.

	Base stars from Tycho Brahe's catalogue	α_{1900}, *hours, minutes and seconds*	β_{1900}, *hours, minutes and seconds*	*Proper motion rate per annum, in arc seconds*		*l = ecliptic longitude*	*b = ecliptic latitude*	*Value*
				V_α	V_δ			
		According to the modern catalogue ([1197])				*According to Tycho Brahe's catalogue ([1024])*		
1	5 γ Ari	1.48.02,4	+18°48'21"	+0.079	–0.108	Ari 27°37.0'	+7°08.5'	4
2	13 α Ari	2.01.32,0	+22°59'23"	+0.190	–0.144	Tau 2°06.0'	+9°57.0'	3
3	74 ε Tau	4.22.46,5	+18°57'31"	+0.108	–0.036	Gem 2°53.0'	–2°36.5'	3
4	87 α Tau	4.30.10,9	+16°18'30"	+0.065	–0.189	Gem 4°12.5'	–5°31.0'	1
5	13 μ Gem	6.16.54,6	+22°33'54"	+0.055	–0.112	Gem 29°44.0'	–0°53.0'	3
6	24 γ Gem	6.31.56,1	+16°29'05"	+0.043	–0.044	Can 3°31.0'	–6°48.5'	2
7	78 β Gem	7.39.11,8	+28°16'04"	–0.627	–0.051	Can 17°43.0'	+6°38.0'	2
8	43 γ Can	8.37.29,9	+21°49'42"	–0.103	–0.043	Leo 1°57.0'	+3°08.0'	4
9	41 γ Leo	10.14.27,6	+20°20'51"	+0.307	–0.151	Leo 23°59.0'	+8°47.0'	2
10	32 α Leo	10.03.02,8	+12°27'22"	–0.249	–0.003	Leo 24°17.0'	+0°26.5'	1
11	29 γ Vir	12.36.35,5	–0°54'03"	–0.568	–0.008	Lib 4°35.5'	+2°50.0'	3
12	67 α Vir	13.19.55,4	–10°38'22"	–0.043	–0.033	Lib 18°16.0'	–1°59.0'	1
13	27 β Lib	15.11.37,4	–9°00'50"	–0.098	–0.023	Vir 13°48.0'	+8°35.0'	2
14	1 δ Oph	16.19.06,2	–3°26'13"	–0.048	–0.145	Vir 26°44.5'	+17°19.0'	3
15	21 α Sco	16.23.16,4	–26°13'26"	–0.007	–0.023	Sag 4°13.0	–4°27.0'	1
16	39 o Sag	18.58.41,4	–21°53'17"	+0.079	–0.060	Cap 9°28.0'	+0°59.0'	4
17	53 α Aqi	19.45.54,2	+8°36'15"	+0.537	+0.385	Cap 26°09.0'	+29°21.5'	2
18	40 γ Capr	21.34.33,1	–17°06'51"	+0.188	–0.022	Aqu 16°14.0'	–2°26.0'	3
19	22 β Aqu	21.26.17,7	–6°00'40"	+0.019	–0.005	Aqu 17°51.0'	+8°42.0'	3
20	54 α Peg	22.59.46,7	+14°40'02"	+0.062	–0.038	Pis 17°56.5'	+19°26.0'	2

Table 9.1. The base stars of Tycho Brahe's catalogue.

The behaviour of the maximal latitudinal error for the stars of the informative kernel with *t* varying from 2.6 to 4.2 is illustrated by a series of drawings similar to fig. 7.10 illustrating the Almagest example (see fig. 9.15).

Parameter area (γ, φ) with solid black shading has the maximal latitudinal error of 2'. The area with regular shading has the error maximum of 2.5'. Fig. 9.15 demonstrates that raising the threshold to the level of 2.5' expands the possible dating interval to 1490-1640 A.D. and not more (instead of the former years 1510-1620 A.D.) If we chose a level of Δ = 3', we would come up with a possible dating interval of 1480-1620 A.D.

Therefore, as is the case with the Almagest catalogue, the boundaries of the possible dating interval for Tycho Brahe's catalogue are only marginally dependent on the level variation of Δ.

Additional calculations demonstrated that the dating interval of Tycho Brahe's observations is also stable in cases of informative kernel contingent variation.

2.5. Conclusions

1) Our method as applied to Tycho Brahe's catalogue yields a possible dating interval of 110 years (between 1510 and 1601 A.D.) The resulting interval covers the lifetime of Tycho Brahe (1546-1601). The period of Tycho Brahe's observations in the observatory of Uraniborg (1576-1597) locates in the middle of this period, or around 1565.

Constellation. Number of stars in a constellation	*Turn of the celestial sphere*	*The percentage of stars in a constellation whose latitudinal error rate doesn't exceed the value of:*			*Residual square average discrepancy* $\hat{\sigma}$
		1'	*2'*	*3'*	
Cancer, 13 stars	- (condition before the turn)	38	77	77	2.40'
	optimal for *Zod A*	61	85	92	2.37'
	optimal for constellation	61	77	92	2.37'
	$\gamma = \gamma^{ZodA}_{stat}(t)$, $\varphi = 0$	46	77	92	2.37'
Leo, 36 stars	- (condition before the turn)	61	83	94	1.41'
	optimal for *Zod A*	55	80	94	1.44'
	optimal for constellation	61	83	94	1.35'
	$\gamma = \gamma^{ZodA}_{stat}(t)$, $\varphi = 0$	47	75	94	1.63'
Taurus, 37 stars	- (condition before the turn)	76	89	94	1.18'
	optimal for *Zod A*	54	92	97	1.31'
	optimal for constellation	67	92	94	1.17'
	$\gamma = \gamma^{ZodA}_{stat}(t)$, $\varphi = 0$	24	62	94	1.94'
Pisces, 31 stars	- (condition before the turn)	61	77	90	1.81'
	optimal for *Zod A*	48	81	90	1.97'
	optimal for constellation	64	81	90	1.79'
	$\gamma = \gamma^{ZodA}_{stat}(t)$, $\varphi = 0$	45	77	87	1.87'
Aquarius, 34 stars	- (condition before the turn)	29	56	76	2.49'
	optimal for *Zod A*	32	59	82	2.23'
	optimal for constellation	35	82	91	1.63'
	$\gamma = \gamma^{ZodA}_{stat}(t)$, $\varphi = 0$	38	65	91	1.90'
Virgo, 32 stars	- (condition before the turn)	25	72	94	1.80'
	optimal for *Zod A*	34	72	94	1.83'
	optimal for constellation	62	91	100	1.16'
	$\gamma = \gamma^{ZodA}_{stat}(t)$, $\varphi = 0$	59	91	94	1.22'
Aries, 20 stars	– (condition before the turn)	65	85	100	1.22'
	optimal for *Zod A*	60	40	100	1.21'
	optimal for constellation	50	95	100	1.20'
	$\gamma = \gamma^{ZodA}_{stat}(t)$, $\varphi = 0$	45	65	90	1.63'
Ophiuchus, 24 stars	- (condition before the turn)	17	37	70	2.84'
	optimal for *Zod A*	46	79	92	1.93'
	optimal for constellation	50	92	92	1.69'
	$\gamma = \gamma^{ZodA}_{stat}(t)$, $\varphi = 0$	25	54	83	2.40'

Table 9.2. Calculation results for Tycho Brahe's catalogue.

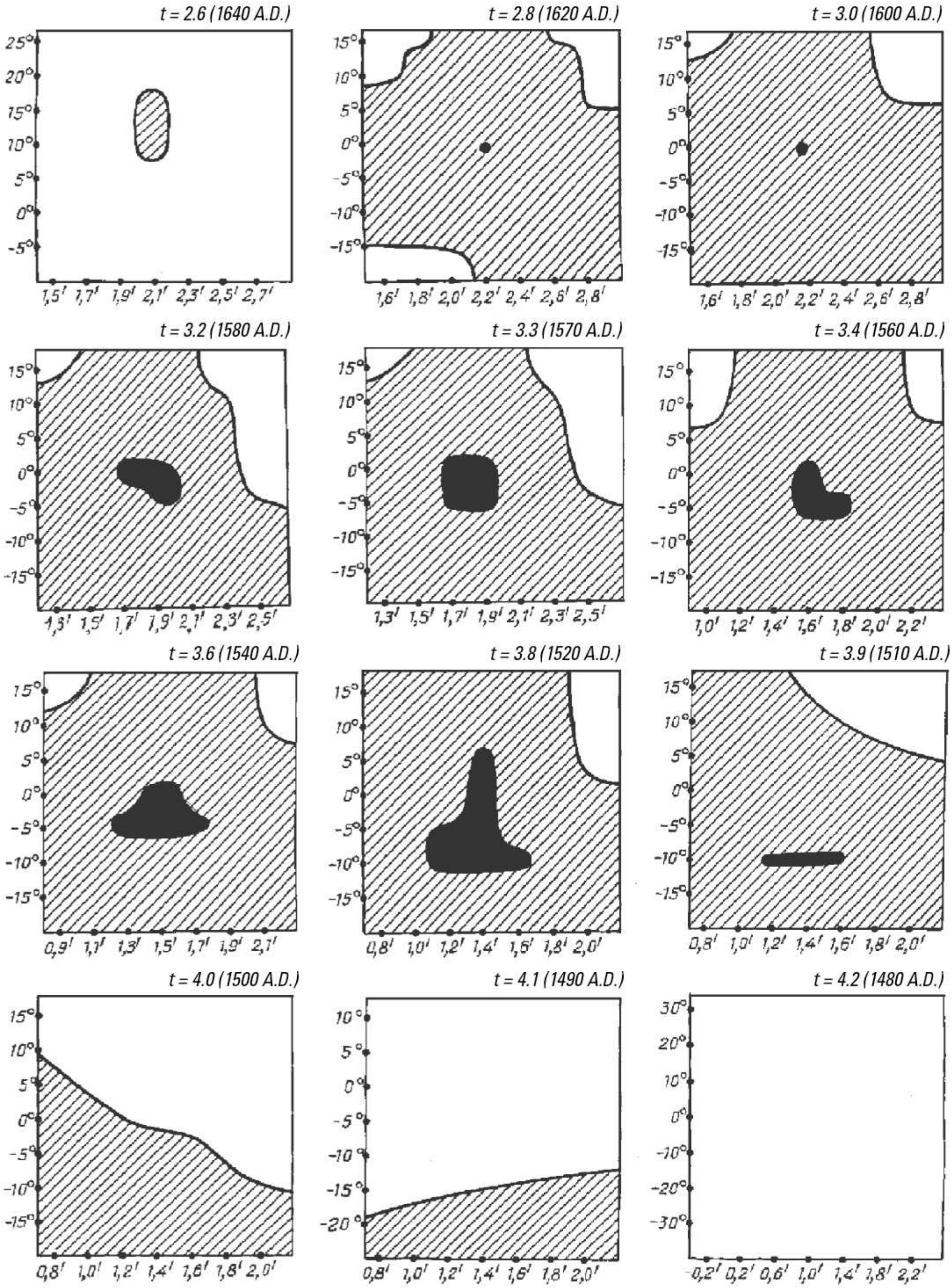


Fig. 9.15. Maximal latitudinal discrepancy $\Delta(t, \gamma, \varphi)$ for Tycho Brahe's catalogue, for t values ranging between 2.6 and 4.2, or 1480 A.D. to 1640 A.D. Area with Δ no more than 2' is shaded black; area with Δ no more than 2'30" has regular shading.

2) Possible dating interval of Tycho Brahe's observation demonstrates a good level of stability under variations of Δ level as well as variations in the informative kernel contingent. Raising the Δ level from 2' to 3' makes this interval grow to 200 years (1480-1680 A.D.)

3) The resulting possible dating interval equalling 110 years is roughly 6 times shorter than the one calculated for the Almagest (700 years). This corresponds to the fact that Tycho Brahe's catalogue is 5-6 times more precise than the Almagest – namely, it has an error threshold of 2'-3' as opposed to 10'-15'.

4) The statistical possible dating interval of Tycho Brahe's catalogue correlates with the geometrical interval for trust levels of $1 - \varepsilon > 0.9$.

3. ULUGBEK'S CATALOGUE

3.1. A general characteristic of Ulugbek's catalogue and its dating result

Ulugbek's catalogue is presumed to be a more precise version of the Almagest star catalogue based on the astronomical observations performed in the observatory of Samarkand in the middle of the XV century A.D., in the reign of king Ulugbek ([1339]). However, according to Peters and Knobel, "although Ulugbek did in fact compile a more precise catalogue of Ptolemaic stars, this catalogue never became widely-used" ([1339], page 7). A study of Ulugbek's catalogue demonstrates that it is de facto a catalogue of Ptolemaic stars. It isn't just the stellar contingent that coincides for both catalogues, but also the order of stars as listed in Ulugbek's catalogue and the Almagest, exceptions being few and far between. There are 1019 stars in Ulugbek's catalogue. Ecliptical coordinate values are given to the minute, yet the real precision of this catalogue is substantially lower. Some researchers estimated it to equal 3'-5' (see [65]). However, our calculations demonstrate the residual dispersion of the latitudinal error in Ulugbek's catalogue to equal 16.5' for celestial area *Zod A*, which is where we find the catalogue at its most precise. Thus, the real latitudinal precision of Ulugbek's catalogue is about 30'-35', which is lower than that of the Almagest to a great extent!

On the other hand, systematic error γ is smaller in Ulugbek's catalogue than in the Almagest. As a result, latitudinal precision of the former in its initial form, or prior to the exclusion of the systematic error, is somewhat higher than the latitudinal precision in the original text of the Almagest catalogue. The difference equals 5'-6'. However, this difference is rather insubstantial when compared to the rate of the (latitudinal) error in both catalogues taken in their initial form, without the compensation of the systematic error. It is hardly surprising that Ulugbek's catalogue never replaced the Almagest in scientific circulations. In fig. 9.15a we cite the title page from Ulugbek's catalogue.

The histogram of Ulugbek catalogue's latitudinal error rate for the stars from celestial area A can be seen in fig. 9.16. Before the histogram was built, all the stars whose latitudinal discrepancy exceeded 1 degree for $t = 5$, or 1400 A.D., were excluded from consideration.

Our calculations also demonstrate that Ulugbek's catalogue contains outright borrowings from the Almagest (or vice versa). In fig. 9.17 we see a difference histogram between stellar latitudes in Ulugbek's catalogue and the latitudes of the respective stars in


SIVE
TABVLÆ
LONG. AC LAT STELLARUM FIXARVM,
EX OBSERVATIONE
ULUGH BEIGHI,
TAMERLANIS Magni Nepotis, Regionum ultra citráque GJIHUN (i. Oxum) Principis potentissimi.
Ex tribus invicem collatis MSS Persicis jam primùm Luce ac Latio donavit, & Commentariis illustravit THOMAS HYDE A M. e Coll Reginæ Oxon
In Calce Libri accesserunt MOHAMMEDIS TIZINI Tabulæ Declinationum & Rectarum Ascensionum.
Additur demum Elenchus Nominum Stellarum
OXONI
Typis Henrici Hall Academiæ Typographi Sumptibus Authoris. Venales prostant apud Richardum Davis Bibliopolam. CIↃIↃCLXV

Fig. 9.15a. Title page of Ulugbek's catalogue.

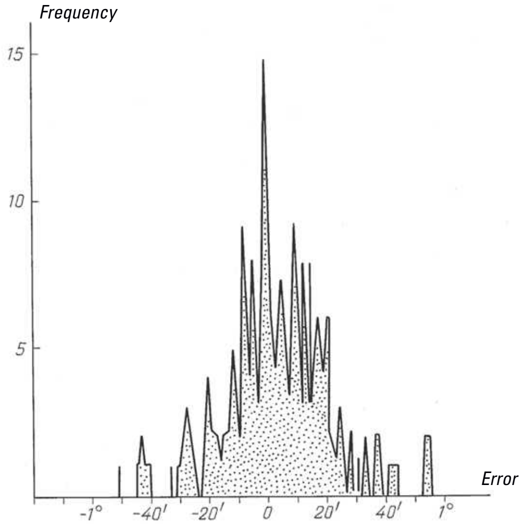


Fig. 9.16. Latitudinal discrepancy histogram for celestial area *Zod A* in Ulugbek's catalogue, with $t = 5$.

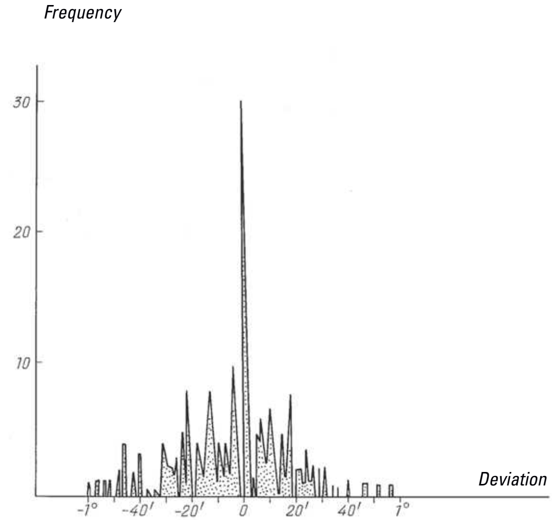


Fig. 9.17. Difference frequency histogram for stellar latitudes from Ulugbek's catalogue and the Almagest, without systematic error compensation (Ulugbek – Almagest).

the Almagest. Identifying Ulugbek's stars as their Almagest counterparts presents no problems since, as it has been pointed out, the order of stars coincides for both catalogues.

The abrupt peak at zero in fig. 9.17 corresponds to the group of stars whose latitudes coincide completely in both catalogues. This peak is great enough to leave no room for speculation about its being of a random character.

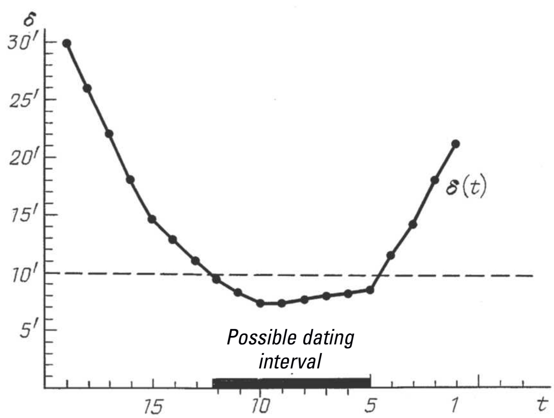


Fig. 9.18. Minimal discrepancy graph of $\Delta(t)$ for the stars from the informative kernel of Ulugbek's catalogue, depending on the presumed dating t.

3.2. Systematic errors in Ulugbek's catalogue

Parameters of the systematic error $\gamma_{stat}(t)$ and $\varphi_{stat}(t)$ were calculated for celestial region *Zod A* from Ulugbek's catalogue with the alleged datings ranging from 100 B.C. and 1800 A.D. ($1 \le t \le 20$). See section 2 of Chapter 6 for more details concerning the calculation of $\gamma_{stat}(t)$ and $\varphi_{stat}(t)$. The results of $\gamma_{stat}(t)$ and $\varphi_{stat}(t)$ computations for the three presumed datings of 1500 A.D. ($t = 4$), 900 A.D. ($t = 10$) and 400 A.D. ($t = 15$) are compiled in table 9.3, which is where we also find the square average error values of $\hat{\sigma}$ before and after the compensation of the systematic error with parameters $\gamma = \gamma_{stat}$ and $\varphi = \varphi_{stat}$.

3.3. The choice of the informative kernel and the Δ threshold. The dating of Ulugbek's catalogue

Let us compile the informative kernel of Ulugbek's catalogue using named stars from area *A* as the most thoroughly observed part of the sky and its immediate vicinity, just as we did in the dating of the Almagest catalogue. We shall come up with the same 9 stars from area A as we find named in the Almagest, i. e.:

Arcturus = α Boo, Regulus = α Leo, Spica = α Vir, Antares = α Sco, Capella = α Aur, Lyra = Vega = α Lyr, Aselli = α Can, Procyon = α CMi and Previndemiatrix = ε Vir.

This time we do not exclude the star Previndemiatrix from consideration the way we did in case of the Almagest, since its coordinates in Ulugbek's catalogue aren't a result of later calculations, and hence appear to contain no scribe errors ([1024]).

According to table 9.3, we must choose 10' as the value of precision threshold Δ for the latitudes of named stars from celestial area *A*, as we have done in case of the Almagest. Indeed, the mean-square latitudinal discrepancy for celestial area *Zod A* equals 16.5' after the compensation of the systematic error. 45% of the stars from this area have a residual latitudinal error of 10' maximum after the compensation of the systematic error.

Having selected the informative kernel of the catalogue and set the 10' Δ threshold, we get the geometrical interval of possible datings for Ulugbek's catalogue, namely, 700 A.D. – 1450 A.D. The statistical interval of possible datings coincides with the geometrical with a trust level of higher than 0.4. The resultant possible dating interval of Ulugbek's catalogue remains stable when the level of Δ changes, as well as in case varying informative kernel contingent. Thus, for Δ = 15' this interval expands to 400 A.D. – 1600 A.D.

The minimal latitudinal discrepancy graph $\Delta(t)$ for the informative kernel stars is built in fig. 9.18 as a function of the alleged dating *t*. This graph is similar to the one we find in fig. 7.27 as calculated for the Almagest catalogue. Bear in mind that $\Delta(t)$ is the minimum for all possible methods of making the stellar configuration of the informative kernel of Ulugbek's catalogue correspond with the real (calculated) stellar configuration for maximal latitudinal error time moment *t* involving all the stars of the informative kernel. It is obvious that if one fixes the method of superimposing two stellar combinations over each other, one can calculate the latitudinal discrepancy for each star individually and then take the maximal value of this error for all the stars of the configuration. Fig. 9.18 demonstrates in particular the possible dating interval variations of Ulugbek's catalogue that result from the variation of level Δ. A comparison of figs. 9.18 and 7.27 confirms the circumstance that we pointed out above, namely, the fact that the coordinate precision characteristics of both the Almagest and Ulugbek's catalogue are similar to one another.

3.4. Conclusions

1) The geometrical possible dating interval of Ulugbek's catalogue begins in 700 A.D. and ends in 1450 A.D. It covers the Scaligerian dating of the catalogue's creation, which is 1437 A.D., although we observe this dating to be shifted towards the very end of the calculated interval. On the other hand, this interval is remarkably similar to the one we came up with for the Almagest – 600 A.D. to 1300 A.D. It is therefore possible that both catalogues were compiled around the same time.

2) Precision characteristics of Ulugbek's and Ptolemy's catalogues virtually coincide. The systematic compound of the latitudinal error is greater in the Almagest as compared to Ulugbek's catalogue – approximately 20' instead of 10'. The residual random compound for celestial area *Zod A* is, on the other hand, somewhat greater in Ulugbek's catalogue, namely, $\hat{\sigma}$ = 16.5' instead of 12.8'. It was also discovered that the coordinates of 48 stars present in both catalogues coincide completely, which is a result of one catalogue borrowing from the other.

3) The possible dating interval of Ulugbek's catalogue is stable to Δ level changes as well as variations of the informative kernel contingent.

Dates	γ_{stat}	φ_{stat}	σ_{init}	σ_{min}
t = 4, or 1500 A.D.	11.55	–43°	18.36	16.43
t = 10, or 900 A.D.	10.33	–60°	17.92	16.33
t = 15, or 400 A.D.	10.87	–76°	18.1	16.35

Table 9.3. Ulugbek's catalogue. Calculation results $\gamma_{stat}(t)$, $\varphi_{stat}(t)$ for the three presumed datings of 1500 A.D., 900 A.D. and 400 A.D.

4) The statistical possible dating interval of Ulugbek's catalogue coincides with the geometrical interval for any trust level $1 - \varepsilon > 0.4$. If we raise the threshold of Δ to 15', the corresponding statistical interval for $1 - \varepsilon \leq 0.999$ is narrowed to roughly 100 years off the top boundary, reaching up to 1500 A.D. instead of 1600 A.D.

4. THE CATALOGUE OF HEVELIUS

4.1. The dependency between the catalogues of Tycho Brahe and Hevelius

The catalogue of Hevelius was compiled in the second half of the XVII century, already after the invention of the telescope. However, Hevelius was reluctant to use the telescope, considering his naked eye observations to be more precise ([1024]). This was confirmed by Galley after a "competition" of sorts that he entered with Hevelius when they were observing the coordinates of the same stars using different methods – the telescope for Galley and traditional astronomical instruments for Hevelius. The results differed by a mere 1" ([1024]). Literature of the subsequent epochs adhered to the opinion that Hevelius was just as precise in his observations as the astronomers who used telescopes (1-second precision rate). Stellar coordinates in the catalogue of Hevelius are given with arc seconds.

Our analysis does not confirm this popular point of view. We have studied several configurations comprising bright named stars from the catalogue of Hevelius, among which there were three fast stars – Arcturus = α Boo, Sirius – α CMa and Procyon = α CMi. Values of t from the interval of $1 \leq t \leq 5$, or 1400 A.D. – 1800 A.D. were chosen to represent the presumed dating of Hevelius' observations. Moreover, what we tried to find every time was such a superimposition of the stellar configuration from the catalogue of Hevelius over the respective real (calculated) stellar configuration for time moment t for which the maximal latitudinal discrepancy for the configuration stars would be as low as possible. Under "latitudes" we understand the ecliptic latitudes of stars, as usual.

We found out that the celestial sphere rotation parameters that define this optimal superimposition equal zero ($\gamma = 0$, $\varphi = 0$). The implication should be

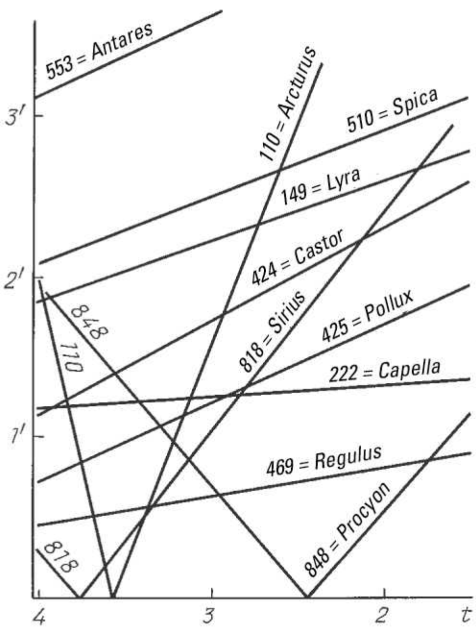


Fig. 9.19. Latitudinal errors in the catalogue of Hevelius.

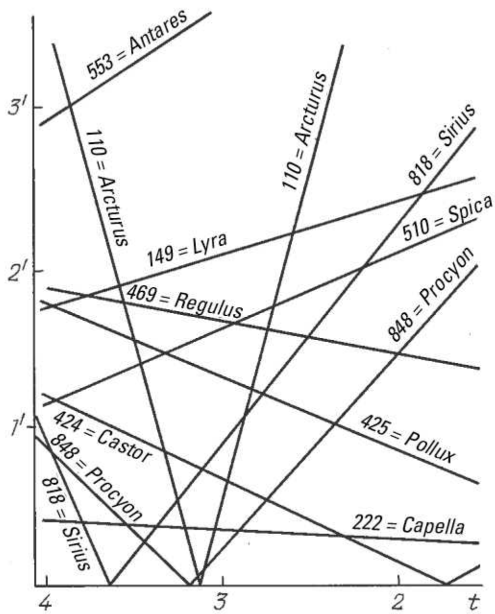


Fig. 9.20. Latitudinal errors in the catalogue of Tycho Brahe.

that the stellar configurations from the catalogue of Hevelius that we studied contain no systematic error, or that there is no shift across the sphere discovered in their coordinates according to Hevelius, which would make the systematic error equal zero. However, random latitudinal errors have the same average rate as those contained in the catalogue of Tycho Brahe, namely, 2'-3'. All of this considering how the scale grade value in the catalogue of Hevelius is 60 times smaller than that of Tycho Brahe's catalogue – 1" instead of 1'. It turns out that the latitudinal errors made by Hevelius are 100-200 times greater than the grade value of his numerical scale!

This circumstance is illustrated in fig. 9.19. It contains the latitudinal error graphs as functions of presumed dating *t* for each of 10 named bright stars from the catalogue of Hevelius:

Arcturus = α Boo, Sirius = α CMa, Procyon = α CMi, Antares = α Sco, Vega = Lyra = α Lyr, Pollux = β Gem, Castor = α Gem, Spica = α Vir, Capella = α Aur and Regulus = α Leo.

In fig. 9.20 we see the same graph built for the catalogue of Tycho Brahe. A comparison of figs. 9.19 and 9.20 demonstrates the latitudinal error to be the same for both catalogues. Furthermore, actual error values for some of the stars contained in the catalogues of Tycho Brahe and Hevelius are close to each other. This applies to Arcturus, Sirius, Antares, Procyon and Lyra = Vega. This is a clear indication of a dependency between the catalogues of Tycho Brahe and Hevelius.

4.2. Conclusions

1) The precision of Hevelius' catalogue is hardly any higher than that of Tycho Brahe's catalogue. This observation is a result of the analysis of bright named star configurations in the catalogue of Hevelius.

2) The catalogue of Hevelius is apparently dependent on the catalogue of Tycho Brahe. This dependency is most obviously manifest for the group of fast bright stars, namely, Arcturus, Sirius and Procyon. As the fast named stars comprise the suggested dating basis of the old star catalogues, the independent dating of Hevelius' catalogues makes no sense at all. The result shall be close to the one we got for Tycho Brahe's catalogue.

5. THE CATALOGUE OF AL-SUFI

We borrowed the star catalogue of Al-Sufi from [1394]. It is usually presumed that the catalogue of Al-Sufi was compiled by the latter from his own observations ([516]). The author opposes himself to the astronomers who use cosmospheres and ready-made catalogues such as the Almagest instead of actual star observations when they compile catalogues under their own names.

He tells us the following:

"I have seen many of those who strive after the knowledge of immobile stars… and discovered them to be people of two categories.

The first category follows the method of the astronomers and uses cosmospheres painted by artists who know not the stars and use the longitudes and the latitudes that they find in books in order to mark the stellar location upon the sphere, unable to tell the truth from the errors. Afterwards knowing people study the spheres and see that the stars drawn thereupon differ from the ones observed in the sky. The makers of cosmospheres make references to astronomical tables whose authors claim to have observed the stars and estimated their positions themselves. In reality, they merely chose the most famous of the stars, the ones known to all such as the Eye of the Bull, the Heart of the Lion [Regulus – Auth.], Virgin's Ear of Wheat [Spica – Auth.], the three stars in the forehead of the Scorpion as well as the heart of the latter [Antares – Auth.] – the very stars whose longitudes and latitudes Ptolemy says to have observed and included in the Almagest, since all of these stars are close to the ecliptic. As for the other stars that Ptolemy indicates in the star catalogue of his book, they would add whichever value they fancied to each one of them. Having shifted these stars in space by the value of the interval between their own lifetimes and that of Ptolemy, they would add several minutes to Ptolemy's longitudes or subtract them from the latter to make the impression that the observations were conducted by themselves alone, and that the process yielded some individual differences in the longitudes and the latitudes regardless of either the general stellar increments or the amount of time that separates them from Ptolemy. All of this was done with no actual

knowledge of the stars. Such are Al-Batani, Atarid and others.

I have carefully studied many copies of the Almagest and found that they differ from the multitude of immobile stars. The second category of people who seek the knowledge of immobile stars consists of amateurs". Quoting according to [544], Volume 4, pages 239-241.

However, the comparison of the stellar coordinates from the Almagest and Al-Sufi's catalogue makes it obvious that the catalogue of Al-Sufi is but one of the numerous existing versions of the Almagest.

Indeed, the order in which the stars are listed in both the Almagest and Al-Sufi's catalogue is exactly the same. The longitudes of all the stars as given by Al-Sufi are made greater with a shift of 12°42' as compared to the Almagest catalogue in its canonical version ([1339]), and the latitudes are exactly the same as in the latter. Let us point out that the shift of longitudes by a single constant, or rendering them to another historical epoch by precession, is indeed present in some of handwritten and printed copies of the Almagest – manuscript 11 from the copy cited in [1339], for instance. This so-called "Venetian Codex 312" contains stellar latitudes 17 degrees greater than Ptolemy's ([1339], page 20).

Peters and Knobel comment as follows: "One sees that the true [according to Peters and Knobel – Auth.] longitudes of Ptolemy, as well as the modified variety, replaced the original figures" ([1339]), page 20. One way or another, what we encounter here qualifies as traces of certain "activities" involving the Almagest catalogue. We see that the longitudes of the Almagest catalogue were shifted into various historical epochs for some reason. Later editors of the Almagest may have initially been of different opinions on what longitudinal shift the catalogue required exactly, and subsequently agreed upon choosing the epoch of the

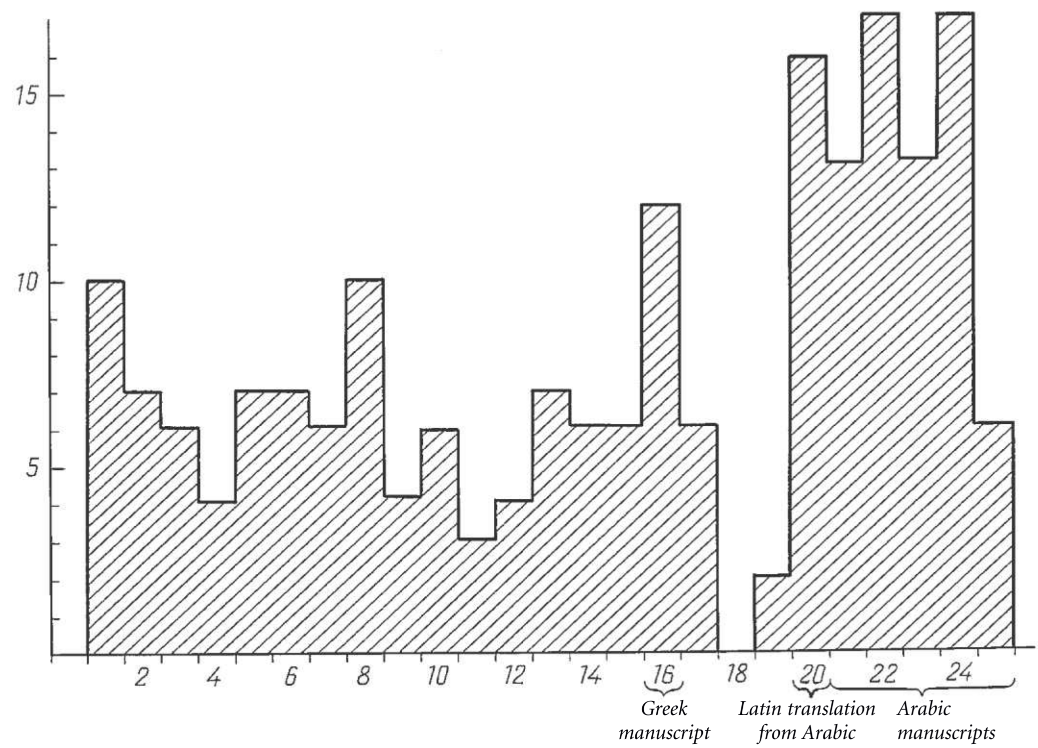


Fig. 9.21. The graph contains the following indications for each of the 25 Almagest manuscripts: the number of cases for which the discrepancy between the latitudes specified by Al-Sufi and the ones in the canonical version of the Almagest equals that of the manuscript under study.

very dawn of the new era. Studying the surviving copies of the Almagest critically in this light would indeed be of value to our research.

Furthermore, it turns out that in the Latin manuscript of the Almagest dating to the alleged year 1490 A.D. became transformed in the following way: "Observing the precession, the scribe added [to the star catalogue – Auth.] the stellar longitudes for the epoch of Adam, having set them to 3496 B.C. and rendered said longitudes to mid-XV century A.D." ([1017]:1), inset between pages 128 and 129. Thus, a Scaligerite historian may well date the Almagest to the antediluvian epoch of Adam – quite erroneously so.

We see yet another longitudinal precision shift of the Almagest catalogue into the epoch of the XVI century A.D. in the Latin edition of the Almagest that dates from 1537 (kept in Cologne; see more about it in Chapter 11).

A comparison of latitudes of all the stars contained in Al-Sufi's catalogue ([1394]) and the canonical version of the Almagest demonstrates that only 53 stars out of 1028 demonstrate differences in latitudes – a very typical rate for different copies of the Almagest. Furthermore, the latitudes for 35 out of these 53 stars of Al-Sufi's coincide with the versions of latitudes contained in the copies of the Almagest studied by Peters and Knobel ([1339]). Thus, the catalogue of Al-Sufi is merely a copy of the Almagest catalogue (we must point out that this conclusion was also made by the astronomer J. Evans ([1119] and [1120]), whose approach was an altogether different one).

In fig. 9.21 one sees the diagram indicating all cases for which the latitudes differing from the canonical version of the Almagest in Al-Sufi's catalogue coincide with those contained in one of the 25 Almagest manuscripts studied by Peters and Knobel in [1339]. The group of handwritten copies of the Almagest which Al-Sufi's catalogue resembles the most is numbered 20-24 in fig. 9.21. It is noteworthy that this group consists of Arabic manuscripts descended from the same prototype – the so-called "translation of Al-Mamon", or the translation of the Almagest that is presumed to have been made by Al-Mamon in the IX century A.D. (see [1339], page 23). Apparently, the catalogue of Al-Sufi contained in [1394] has to be attributed to the same group of Almagest copies.

Let us cite the conclusion made by Peters and Knobel: "Skjellerup's French translation of the Arabic catalogue by Abd Al-Rahman Al-Sufi is merely a version of Ptolemy's catalogue rendered to a different epoch" ([1339], page 7).

Nevertheless, historians carry on claiming Al-Sufi's catalogue to be of an independent nature for some bizarre reason and based on Al-Sufi's own observations which the venerable scholars of history declare to have "pursued the goal of verifying the star catalogues of Ptolemy and the astronomers of the Orient, correcting them according to empirical observation data" ([515], page 190).

We have thus witnessed the star catalogue of the Almagest to have been rendered to various "desired epochs" by different astronomers who used the longitudinal precession method, adding or subtracting some constant value. This could be done for a great variety of reasons. The resulting catalogue could become attributed to a different astronomer – Al-Sufi, for instance. In other cases Ptolemy's name and authorship were kept intact, but the "ancient" Ptolemy himself travelled backwards in time and wound up somewhere around the beginning of the new era due to the "indisputable proof" presented by the longitudes of his catalogue which were magically transformed into "ancient" by proxy of a simple arithmetical operation.

CHAPTER 10

Additional considerations concerning the dating of the Almagest. Stellar coverings and lunar eclipses

A. T. Fomenko, G. V. Nosovskiy

1. INTRODUCTION

The book by A. T. Fomenko V. V. Kalashnikov and G. V. Nosovskiy entitled ***Dating the Almagest Star Catalogue. A Statistical and Geometrical Analysis*** ([METH3]:2) covers the study of the issue of whether one could date the coverings of stars by planets described in the Almagest. The present chapter contains, among other things, additional more precise calculations that we made in this field sometime later.

The dating of the Almagest star catalogue that we came up with in the preceding chapters, basing our research on the geometrical and statistical analysis of stellar latitudes obviously contradicts the consensual dating of the Almagest's compilation (the alleged year 137 A.D.) rather drastically. This leads us to the question of whether the Almagest star catalogue can be a more recent addendum made to an authentic ancient text? Or could the contrary be true – namely, the entire text of the Almagest having been written in 600 A.D. the earliest, and finally edited during a late mediaeval epoch (from the end of the XVI century to the beginning of the XVII century)?

We already mentioned that the astronomical observations collected in the Almagest have been studies meticulously and professionally by Robert Newton, a famous American scientist specializing in celestial mechanics, navigation and astrophysics (see [614]). The result of his research can be formulated as follows briefly: those of the astronomical observation data contained in the Almagest which can be calculated with the aid of Ptolemy's theory as related in the Almagest (including the theory of solar, lunar and planetary motion as well as the precession data) are really nothing else but results of later theoretical calculations made by Ptolemy himself according to Robert Newton (or someone else acting on Ptolemy's behalf). It is therefore pointless to use these "calculated data" for independent astronomical dating purposes nowadays, since the dating of these "calculated observations" implies learning the opinion of a later author, one that lived in the XV-XVII century, in re the time when these astronomical observations took place, and nothing else.

Fortunately, there are observation data contained in the Almagest as well, and these could neither be calculated nor forged by either the theory of Ptolemy or any other astronomical theory of the Middle Ages. Among such data we can definitely count the ecliptic latitudes of 1020 stars contained in the Almagest catalogue. They present a substantial volume of information that we used for a successful dating of the Almagest, qv in the preceding chapters of the book.

The Almagest also contains certain other astronomical data that the modern commentators of the Almagest consider to be the result of "ancient" observations, namely:

I. The four "ancient" observations of stars covered by moving planets.

II. About twenty (namely, 21) "ancient" lunar eclipses mentioned in the Almagest.

Let us point out that the late mediaeval astronomers of the XVI-XVII century may well have tried to calculate the "ancient coverings of stars by planets" using Ptolemy's theory and the periods of planetary rotation around the sun. These periods were already known well in the XVI-XVII century; such knowledge suffices for the calculation of longitudinal correspondence between a star and a planet. Exact covering, or the correspondence of both coordinates, would naturally be beyond their calculation capacity. However, one isn't to exclude the possibility of such imprecise results calculated by mediaeval astronomers and presented as "ancient astronomical observations".

The same is valid for lunar eclipses, and to a greater extent at that. Lunar motion theory as developed by the astronomers of the XV-XVII century would make the approximated calculations of dates and phases of past and future lunar eclipses feasible in the XVII century. Therefore the "ancient" lunar eclipses described in the Almagest could easily have been calculated in the XVI-XVII century. The inevitable lack of precision manifest in mediaeval phase calculations could be declared a result of "errors made by the ancient observer" who would estimate the eclipse phase with the naked eye and hence approximately. Lunar eclipses are less informative this way than coverings, since the fact of covering can be observed with the naked eye, unlike the phase of the eclipse. The hoaxers of the XVI-XVII century were quite capable of including calculated lunar eclipses in the Almagest as proof of its ancient origin.

Another remarkable fact deserves to be mentioned herein. As we shall discuss in more details below, the Almagest doesn't contain any "ancient" solar eclipses. Why would that be? Solar eclipses are a great deal more remarkable than the lunar, after all. One would assume them to be primary candidates for inclusion in the Almagest. We consider the answer to be quite simple. The Almagest in its present form appears to have undergone a great deal of falsification in the XVI-XVII century aimed at making the book seem more ancient. Thus, the Almagest contains a substantial amount of mediaeval theoretical reverse calculations. Solar eclipse theory is more complex than lunar eclipse theory, and calculations of solar eclipses would be a formidable task for the astronomers of the late XVI – early XVII century. This is the apparent reason why they were cautious enough to refrain from including reports of the "ancient" solar eclipse into the "ancient" Almagest – they must have been aware of the fact that later generations of astronomers wouldn't find it too hard to reveal the hoax.

Below we shall consider the issue of dating the planetary coverings of the stars by their descriptions found in the Almagest in more detail. It turns out that this problem has no exact astronomical solution – the only solutions we find are of an approximated nature. The best one we arrived at is mediaeval and concurs well with the dating of the Almagest star catalogue as related above. However, we must reiterate that they cannot serve the end of dating the Almagest independently due to their being approximate. Still one cannot ignore the fact that both approximated mediaeval solutions correspond well to our primary result – the mediaeval dating of the Almagest star catalogue and the comparatively recent XVI-XVII century epoch of its final edition.

We shall consider the possibility of dating the Almagest by the descriptions of lunar eclipses at the end of the present chapter, in section 8.

2. DATING THE PLANETARY COVERINGS OF THE STARS. CALCULATIONS THAT INVOLVE AVERAGE ELEMENTS

It is known well that the Almagest only describes four planetary coverings of the stars (see [614], for instance).

Ptolemy's text runs as follows:

1) Chapter X.4: "Among the ancient observations we have chosen one, described by Timocharis in the following manner: in the 13th year of Philadelphus, on the 17th-18th of the Egyptian Messor, in the 12th hour, Venus completely covered the star located on the opposite of Vindemiatrix" ([1355], page 319).

Ptolemy (in C. Tagliaferro's translation) proceeds to tell us that "the observation had been conducted in the year 406 after Nabonassar" ([1355], page 319). However, the translation of I. N. Veselovskiy tells us that "the year of the observation was 476 after Nabonassar" ([704], page 322). This circumstance was pointed out to us by M. E. Polyakov. C. Tagliaferro might be erring here, since Ptolemy proceeds to cite a calculation demonstrating that 408 years passed between this covering and the year 884 since Nabonassar ([1355], page319). The covering therefore took place in the year 476 since Nabonassar, which we shall be referring to as the primary version hereinafter. On the other hand, it is also possible that C. Tagliaferro was using other versions of the Almagest naming 406 after Nabonassar explicitly. This could result from discrepancies inherent in different copies of the Almagest, so we should formally consider this version as well, which we shall be referring to as "the misprint version".

2) Chapter X.9: "We have considered one of the old observations, which makes it clear that in the 13th year of Dionysius, on the 25th of Aigon, Mars covered the northernmost star on Scorpio's forehead in the morning" ([1355]), page 342.

Ptolemy (in C. Tagliaferro's translation) tells us that "the observations date to the 42nd year after the death of Alexander [or the year 476 since Nabonassar]" ([1355], page 342). The translation made by I. N. Veselovskiy, on the other hand, states that "the time of this observation corresponds to the year 52 after the death of Alexander, or 476 after Nabonassar" ([704], pages 336-337). Either C. Tagliaferro made yet another misprint, or Ptolemy's chronology conceals distortions of some sort. This wouldn't be all that surprising since Ptolemy uses several eras and keeps converting datings from one into another, which could naturally generate errors. At any rate, both translations ([1355] and [704]) cite the same year for the covering of a star by Mars – namely, 476.

3) Chapter XI.3: "We have once again considered a very accurate old observation telling us that in the 45th year of Dionysius, on the 10th of Parthenon, Jupiter covered the Northern Asse" ([1355], page 361).

Furthermore, according to both translations (Tagliaferro's and Veselovskiy's), "this time corresponds to the 83rd year since the death of Alexander" ([1355], page 361; also [704], pages 349-350). There is no discrepancy between the two different translations of the Almagest in this case.

4) Chapter XI.7: "We have considered yet another accurate observation of old, according to which Saturn was located two units below the southern shoulder of Virgo on 5 Xanticus of the Chaldaean year 82" ([1355], page 379).

Later on, both translations (Tagliaferro's and Veselovskiy's) inform us that "the time in question corresponds to the year 519 after Nabonassar" ([1355], page 379; also [704], page 362). There is no discrepancy between the two different translations of the Almagest in this case, either.

According to the known traditional identifications of Ptolemaic stars as their modern counterparts (qv in [614] and [1339]), the coverings in question may be the following ones:

1. Venus covered η Vir around 12.
2. Mars covered β Sco in the morning.
3. Jupiter covered δ Can at dawn.
4. Saturn was observed "two units" lower than γ Vir in the evening.

We have verified these identifications, and they proved correct. The book by A. T. Fomenko, V. V. Kalashnikov and G. V. Nosovskiy ([METH3]:2) uses the middle element values of planetary orbits from G. N. Duboshin's reference book ([262]) for calculations; their latitudinal precision roughly equals 1'. Since we are considering the issue of calculation precision, let us clarify what exactly it is that we mean by saying "a planet covered a star".

It is common knowledge that human eye can distinguish between two points located at the angle distance of 1'. For the people with a particularly keen eyesight this distance may equal 30". The matter is that the characteristic size of retinal cones in the centre of the eye-ground corresponds to 24". Thus, the covering of a star by a planet, or their mutual superimposition, actually means that the angle distance between them roughly equals 1' as seen from the Earth.

Modern theory allows to calculate past positions of Venus and Mars with the latitudinal precision of 1' on the historical time interval that interests us. The precision of calculating the latitudes of moving Mars and Venus equals circa 3'. This suffices, since it is the latitudinal value that defines the fact of a star covered by a planet. A planet's longitude alters rather rapidly

as compared to its latitude. Locally, the longitude can be regarded as proportional to time. Thus, the error of several arc minutes in the estimation of the longitude only leads to a very minor error in the estimation of the moment when a planet covered a star. Therefore in case of Venus and Mars the coverings described by Ptolemy can be calculated with sufficient precision once we use modern theory as a basis.

The motion theory of Jupiter and Saturn is more complex and somewhat less precise than the one used for Venus and Mars. V. K. Abalakin is right enough to point out that "insofar as the external planets are concerned (Jupiter, Saturn, Uranus, Neptune and Pluto) … the middle orbital elements [of these planets] can in no way be used for the solution of the stability problem and remain applicable for intervals of several million years … [they are] only of utility for the period of several centuries before and after the present epoch" ([1], page 302).

However, in case of the Almagest we are in no need of ultra-precise formulae. The reason is that, according to the Almagest, the observation of Saturn is of secondary importance, since Saturn did not cover the star, but rather was observed at the distance of "two units" from it; as for the actual Ptolemaic definition of a "unit", the issue remains unclear. Therefore calculating the positions of Saturn with the precision of 1' is of no use to us.

As for Jupiter, Ptolemy might claim it to have "covered a star"; however, modern theoretic calculations demonstrate that Jupiter didn't approach the δ of Cancer closer than 15' anywhere on the historical interval; therefore, we have to search for moments where the distance between Jupiter and the star in question equalled 15'-20'. Extreme precision of formulae isn't needed for this purpose; the level guaranteed by the modern theory is quite sufficient.

Let us now address the issue of just how these four coverings are dated by Ptolemy (see table 10.1). The primary era used by Ptolemy is the era of Nabonassar ([1355]). He is most prone to using it for re-calculating the datings of ancient observations. He also uses other chronological eras. Let us cite the table of datings containing the abovementioned Ptolemaic coverings of stars by planets. Ptolemy had used each of the following three eras at least twice: the era of Nabonassar, the era of Alexander and the era of Dyonisius.

We end up with the following intervals between the coverings:

a) A maximum of one year between the coverings by Venus and Mars (476 and 476). If the "misprint version" contains no misprint really, the interval shall equal 70 years: 476 – 406 = 70.

b) 32 years by the era of Dionysius between the coverings by Mars and Jupiter (45 – 13 = 32), or, alternatively, circa 31 years by the era of Alexander (83 – 52 = 31).

c) Around 11 years between the Jupiter and Saturn coverings (519 – 508 = 11).

If the abovementioned discrepancies between the translations of the Almagest made by C. Tagliaferro and I. N. Veselovskiy aren't a result of misprints but rather stem from actual discrepancies between actual manuscripts of the Almagest (of which there were many, qv in Chapter 11), table 10.1 demonstrates that the Ptolemaic chronology contains possible errors. The other possibility, and also an interesting one, is the presence of errors even in the modern editions of the Almagest which were meticulously verified by scientists. The fact that Ptolemy's chronology wasn't error-free is demonstrated by table 10.1 as cited above. Indeed, the interval between the coverings by Mars and Jupiter equals 32 years by the era of Dionysius (45 – 13 = 32). If we are to take the era of Alexander, this

The covering of a star by a planet	*Year according to Ptolemy*		
	Nabonassar's Era	*Alexander's Era*	*The Era of Dionysius*
1) Venus	476 or 406 (406 is a misprint?)		
2) Mars	476	52 or 42 (42 is a misprint?)	13
3) Jupiter		83	45
4) Saturn	519		

Table 10.1. The datings of planets covering stars as indicated in the Almagest.

interval equals 31 years (83 – 52 = 31). The discrepancy equals one year.

The star in question was covered by Jupiter in the year 508 after Nabonassar, according to Ptolemy. This is easily implied by Table 10.1.

Let us formulate a precise mathematical problem, qv in fig. 10.1. We have to determine the following combination of astronomical events:

1) In a certain year N, or the year $N - 70$, Venus covered the η of Virgo around 12 o'clock.

2) In the year N Mars covered the β of Scorpio in the morning.

3) In the year $N + 32$ (or $N + 31$) Jupiter covered the δ of Cancer at dawn.

4) In the year $N + 43$ Saturn was located near the γ of Virgo in the evening, being somewhat lower than the star in question.

Let us now discuss the issue of just what precision rate is needed to satisfy to the time intervals between the planetary coverings of the stars as listed above. It is obvious that we need a leeway of two years minimum, since all the dates were rendered to a single era, which can yield the natural error of 1-2 years in formal calculation due to the simple fact that different eras used different points to mark the beginning of the year (such points are known to have included March, August, September, October and January). Variable beginning of the year was also used ([1155]). We have agreed upon the acceptable discrepancy interval of 4 years, which means that the discovered time interval cannot differ from the Ptolemaic by more than 4 years.

As a result, we have to find four coverings with the following intervals between them:

a) A maximum of one year between the coverings by Venus and Mars, with the aberration rate of 4 years. If the "misprint version" contains no misprint in reality, the interval must cover 70 years, maximal aberration rate equalling 4 years.

b) 31 or 32 years between the coverings by Mars and Jupiter with the aberration rate of 4 years.

c) 11 years between the coverings by Jupiter and Saturn with the aberration rate of 4 years.

We have therefore formulated a precise mathematical problem. Let us proceed to formulate the solution we came up with, which is the result of middle element calculations.

There are only three solutions of the formulated mathematical problem on the historical interval between 500 B.C. and 1700 A.D. These solutions are approximated and not precise.

The first solution (mediaeval, X-XI century).

This solution was obtained by A. T. Fomenko, V. V. Kalashnikov and G. V. Nosovskiy and described in [METH3]:2.

1a). On 18 October, 960 A.D., Venus covered the η of Virgo. The calculated distance equals 1'-2' in this case.

1b). In the "misprint version" (qv above) this covering took place in 887 A.D., on the 9th of September. The calculated distance between them is less than 1'. However, the observation conditions here were rather poor.

1c). The "misprint version" allows for another solution – namely, the Venus covering in question may have taken place a year later, in 888 A.D., on the 21st of October. The calculated distance between then is less than 5' in this case.

2) In 959 A.D. Mars covered the β of Scorpio on the 14th of February. The calculated distance between them equals 15'.

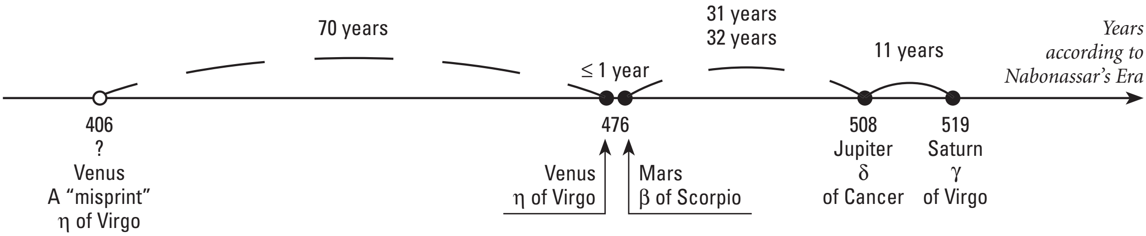


Fig. 10.1. Four observations of planets covering stars as mentioned in the Almagest. The datings are given according to the Era of Nabonassar used by Ptolemy.

3) In 994 A.D., on the 25th of July, Jupiter was at the distance of roughly 15' from the δ of Cancer. A propos, this distance is close to the minimal possible distance between the star and the planet in question on the entire historical interval under study.

4) On the 16th of August, 1009 A.D., Saturn was at the distance of 25'-30' from the γ of Virgo, below the star.

The maximal "leeway interval" in the intervals between the subsequent observations equals 4 years for the first solution if we are to measure all of the Ptolemaic distances in years. Indeed:

a) The interval between the Venus and Mars coverings equals one year, namely, 960 A.D. for Venus and 959 A.D. for Mars. The maximal distance we need is one year ± 4 years.

b) The interval between the Mars and Jupiter coverings equals 35 years: 959 A.D. for Mars and 994 A.D. for Jupiter. We needed 31 or 32 ± 4 years.

c) The interval between the Jupiter and Saturn coverings equals 15 years: 994 A.D. for Jupiter and 1009 A.D. for Saturn. We needed 11 ± 4 years.

The second solution ("traditional", III century B.C.). It is exposed, for instance, in Robert Newton's book ([614], page 335).

1) The night of 11-12 October, 272 B.C. (or the year –271) saw Venus approach the η of Virgo. The distance between Venus and the Star in question equalled about 1'-3'.

2) In the morning of either the 18th or the 16th of January, 272 B.C. (or the year –271) Mars "approached" the β of Scorpio. However, according to Y. A. Grebenikov, the scientific editor of the Russian edition of R. Newton's book, on the 18th of January, in the morning, "Mars was at the distance of circa 50' from the β of Scorpio at the moment of observation [ARO, section XI.4], and such a distance can hardly be regarded as close proximity. However, Mars and the star in questions were very close to each other on the 16th of January, –271, and so the date may have either been written erroneously or misinterpreted by Ptolemy" ([614], page 312, comment 3). According to our calculations, the distance between Mars and the star equalled circa 50'-55' on the 18th of January, 272 B.C., and was more than 15' (more precisely, 17'-18') on the 16th; this solution is therefore a dubious one.

3) In the morning of the 4th September, 241 B.C., Jupiter "approached" the δ of Cancer. However, calculations demonstrate that the distance between Jupiter and the star in question was greater than 25'.

4) On the 1st of March, 229 B.C., Saturn was at the distance of some 30' from the γ of Virgo.

All the datings are given according to the Julian calendar with the beginning of the year falling on the 1st of January.

In the "ancient" solution the intervals between the coverings are as follows: the Mars and Venus coverings took place the same year, the Mars and Jupiter coverings were separated by the interval of 31 years, and the Jupiter and Saturn coverings are located at the distance of 12 years from each other.

The third solution (late Middle Ages, XV-XVI century). This solution was discovered by A. T. Fomenko and G. V. Nosovskiy.

1) On the 19th of September, 1496 A.D., Venus covered the η of Virgo. The calculated distance is less than 1' in this case.

2) In 1497 A.D., on the 19th of January, Mars covered the β of Scorpio. The calculated distance between them is circa 15'.

3) In 1528 A.D., on the 3rd of June, Jupiter approached the δ of Cancer, the distance between them equalling circa 25'.

4) In 1539 A.D., on the 5th of September, Saturn was some 25' below the γ of Virgo.

The late mediaeval XV-XVI century solution has a leeway of 1 year maximum for the datings of the Ptolemaic intervals between consecutive observations. From the point of view of time intervals between coverings, this solution is the best of the three – it is ideal. Indeed:

a) The interval between the coverings by Venus and Mars equals a mere four months (19 September 1496 A.D. for Venus and 19 January 1497 A.D. for Mars). Less than one year, in other words; this fits into the required Ptolemaic interval perfectly.

b) The interval between the Mars and Jupiter coverings equals 31 years: 1497 A.D. for Mars and 1528 A.D. for Jupiter. According to Ptolemy, we need 31 or 32 years.

c) The interval between the Jupiter and Saturn coverings equals 11 years: 1528 A.D. for Jupiter and 1539 A.D. for Saturn. This is the exact period required according to Ptolemy – eleven years.

As we shall see below, the "ancient" solution is visibly worse than the mediaeval solutions that we calculated. The chronologists who studied the Almagest could not satisfy to Ptolemy's specifications. It is also obvious that the chronologists didn't make the emphasis on either the correspondence between the observation described by Ptolemy and modern calculations, or even the datings of these observations given by Ptolemy himself, but rather the ambiguous interpretation of Ptolemy's names for months and such astronomical characteristics as the longitude of the sun, the moment of observation, planetary longitude etc, which were calculated by Ptolemy with the use of a rather imprecise theory.

These data cannot serve as basis for the dating of the actual observations, at any rate. The dating should be based on the observation characteristics that Ptolemy cites as opposed to calculating, namely, the year when a star was covered by a planet and the actual fact of this covering.

The X-XI century solution satisfies to Ptolemy's description the best. Let us point out that it is located in the middle of the possible dating interval that we calculated for Ptolemy's star catalogue. The late mediaeval solution of the XV-XVI century A.D. is also possible from the point of view of the New Chronology. As a matter of fact, the ancient solution is located at the distance of 1800 years from the late mediaeval solution, which is the value of one of the key chronological shifts inherent in the Scaligerian version of history, qv in CHRON1. The existence of several solutions, among them the "ancient" one of the III century B.C. is explained by the existence of certain periods in planetary coverings of the stars. The flat configuration of the Earth and the planets that defines the possibility of observing these coverings from the Earth (provided that the planetary orbital planes are located at a satisfactory angle from the ecliptic) changes over the course of times; these changes conform to an approximated periodic law. Indeed, the dynamics of this configuration can be described as the movement of a point along the winding of a multidimensional torus. However, the angles between the orbital planetary planes and the ecliptic gradually alter with the course of time. It turns out that an entire period can pass over the time needed for these alterations to "distort" the necessary configuration of planetary orbits.

3. THE DATING OF THE PLANETARY STAR COVERINGS DESCRIBED IN THE ALMAGEST. A MORE PRECISE CALCULATION

3.1. The adjusted algorithm

Our calculations of the planetary coverings of the stars cited in the previous section were based on the astronomical formulae taken from the reference book by G. N. Duboshin ([262]). Also, when A. T. Fomenko, V. V. Kalashnikov and G. V. Nosovskiy were conducting these calculations in 1990, only the middle orbital elements were used. These were estimated precisely enough in the XIX-XX century; however, if we don't account for periodic additions, we shall come up with somewhat rough planetary positions. The lack of these periodic additions in our calculations of planetary coverings is clearly visible from the planetary formulae that we cited in [METH3]:2. These calculations sufficed for the ends we were pursuing at the time. Indeed, purely geometrical considerations make it obvious that the approximated solution that we came up with using the middle elements happens to be stable enough. We can therefore use it for obtaining a precise solution if we "move the dates about" somewhat. We weren't looking for this precise solution at the time and didn't go beyond rough calculations (which reflected the situation well enough all the same) for the following reasons.

Firstly, the calculations of the planetary coverings of the stars are of secondary importance. They are beyond the scope of the primary issue, which is the dating of old star catalogues, and can only be used for defining the possible directions of further analysis of the Almagest with the aim of dating its other parts, not just the star catalogue.

The second reason why we hadn't used the more precise planetary theory back then and resorted to the rather rough yet stable middle element formulae is as follows. Before the 1980's there were several different versions of the planetary calculation theory which gave inconsistent answers for distant epochs. This is easy to understand. All attempts of making the planetary formulae more precise are based on different empirical corrections to a large extent. These corrections result from modern observations. This implies

their utility for the purpose of making modern formulae more precise. However, the issue of just how useful these corrections are for faraway epochs, and whether any such corrections can be made at all, is far from simple.

Over the last couple of years, the calculation methods used in planetary theory were improved to a great extent. Different teams of astronomers were using different approaches, and they all came up with formulae which give very precise solutions even for distant epochs.

This is far from being absolute proof of the validity of such theories as applied to the epochs in question, but it is valid enough. In general, the present situation in planetary theory calculations differs from the one reflected in the book by G. N. Duboshin ([262]) in 1976.

Therefore, nowadays it makes sense to return to the problem of dating the planetary coverings of stars with the use of more precise and up-to-date formulae accounting for periodical perturbations. We have done this in 1997-1999 using the Turbo-Sky software as well as more precise software.

We have used the well-known PLANETAP application for precise calculations. Its authors are J. L Simon, P. Bretagnon, J. Chapront, M. Chapront-Touze, G. Francou and J. Laskar (Bureau des Longitudes, URA 707. 77, Avenue Denfert-Rochereau 75014, Paris, France). It is used for calculating the heliocentric coordinates, radius vectors and instantaneous speeds for the 8 main planets of the Solar System (PLANETAP, Fortran 77) – Astron. Astrophys, 282 and 663 (1994).

This software allows to determine the visibility conditions of celestial bodies in relation to the local horizon for any location on Earth, depending on the time and the place of the observation. It can therefore be used for the verification of such details found in Ptolemy's descriptions of coverings as the time of day (morning, dawn, evening etc). Our previous and less precise calculations did not allow for taking these details into account.

3.2. The discussion of the mediaeval X-XI century solution

Let us begin with the discussion of the mediaeval solution (the X-XI century A.D.) in its final, somewhat adjusted version (as compared to the one found in [METH3]:2). The solution is as follows:

Venus: 960 A.D. We come up with either 888 A.D. or 887 A.D. for the "misprint version", which is worse.

Mars: 959 A.D.

Jupiter: 994 A.D.

Saturn: 1009 A.D.

This solution satisfies to Ptolemy's description with a great deal more precision than our previous middle element calculations. In other words, the astronomical software PLANETUP ([1405:1]) didn't simply confirm the prior rough result, or the very fact that the astronomical solution of the problem does in fact exist, but also demonstrated an almost complete concurrence of this astronomical solution to the additional details reported by Ptolemy in the Almagest.

Below we shall discuss yet another solution that we found – the late mediaeval one (XV-XVI century).

Let us remind the reader of the exact nature of the problem at hand. The most important fact is that the complete superimposition of stellar and planetary coordinates on the celestial sphere implies the proximity range of less than one minute. Even in the XVIII century, no reverse theoretical calculation of such an event could have been made. Unfortunately, there is no ideal solution to be found anywhere. For instance, Jupiter does not get closer than 10' to the star that it is supposed to cover. This makes the observations a lot less useful for the ends of independent dating. One wonders whether the data could be distorted or falsified; this is the consideration voiced by R. Newton in [614]. However, he could not prove the falsity of these observations, and wrote that they "might prove authentic" in the commentary ([614], page 335).

Nevertheless, if we are to interpret Ptolemy's reports of planets covering stars as indicating close proximity between the two, we may well come up with a solution whose temporal intervals shall be just as Ptolemy specifies them. One can naturally find several such solutions since the very concept of covering becomes rather vague. Scaligerian chronologists suggest one such solution – the III century B.C., qv above.

The two other solutions were found by the authors. They are more precise than the "Scaligerian", and one of them corresponds to the very middle of

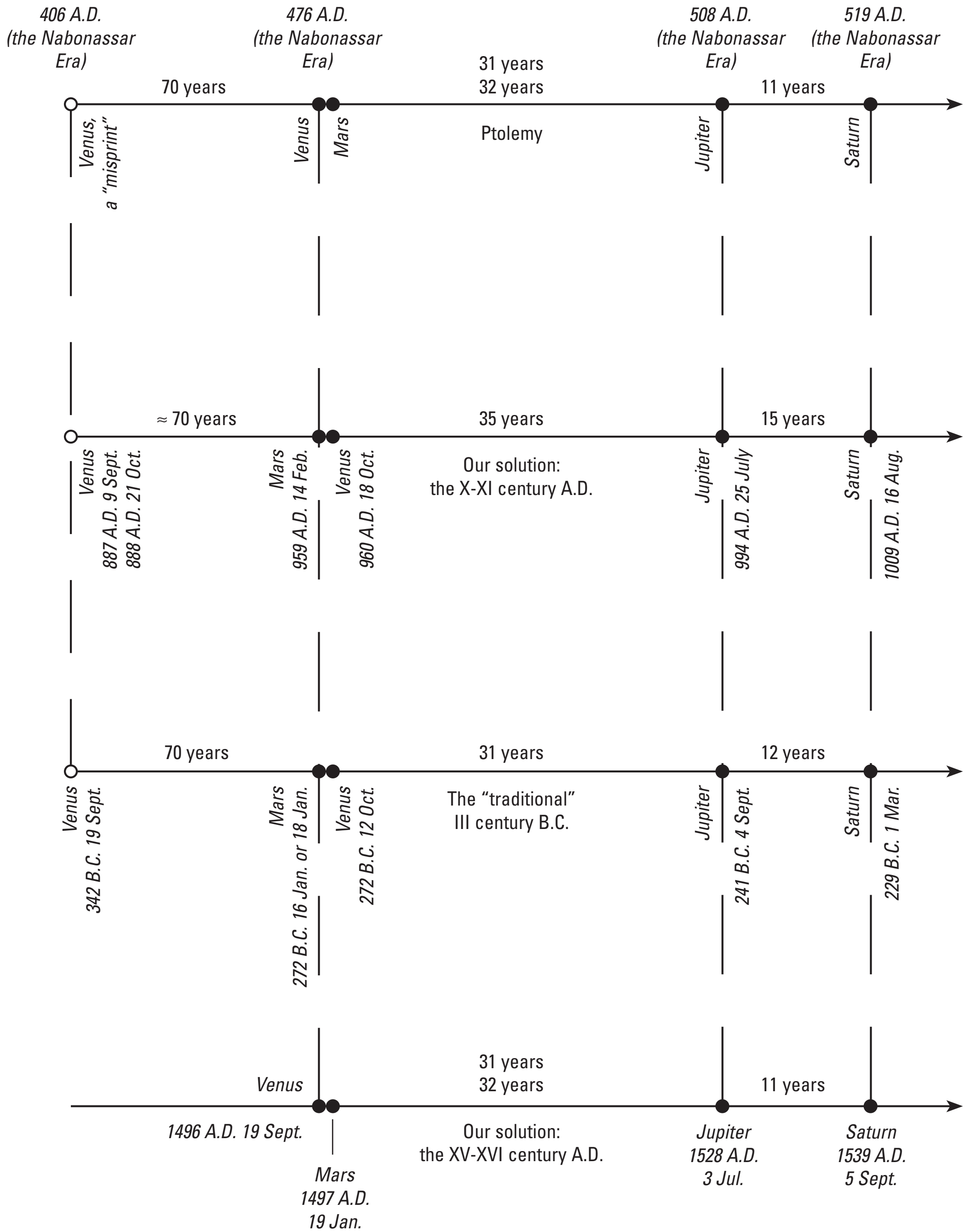


Fig. 10.2. The three astronomical solutions of the problem of planets covering stars. The top line stands for Almagest data, the one in the middle – for our solution of the X-XI century. The third line represents the "traditional" solution of the III century B.C., and the fourth one corresponds to our solution of the XV-XVI century.

the Almagest star catalogue dating interval – namely, the epoch of the X-XI century. This make it concur very well with the independent dating of the star catalogue. The second late mediaeval solution of the XV-XVI century that we discovered is also of interest and shall be discussed below.

Let us emphasize that the only data we used for our choice of a solution were those Ptolemy claims to borrow from his ancient predecessors. His own considerations and calculations based on these observations were not taken into account (such as his "mid-solar position" calculations etc). Among other things, these calculations represent the attempt of either the author himself or a late mediaeval editor to date these "ancient" observations. Therefore, the analysis of these Ptolemaic calculations shall most probably give us the chronological opinions of the XVI-XVII century observer. These may have been taken from the works of either Scaliger or even Kepler in the XVI-XVII century and can only complicate our own calculations. Planetary positions in the past could already be calculated with sufficient precision in the epoch of Scaliger and Kepler; the chronologist who edited the Almagest may well have decided to "date" these observations to the III century B.C.

Let us consider the details. We must reiterate that according to the well-known traditional identifications of Ptolemaic stars as their modern counterparts ([614]), the Almagest reports the following four planetary coverings of stars:

1) Venus covering the η of Virgo "around twelve o'clock", according to Ptolemy.

2) Mars covering the β of Scorpio in the morning.

3) Jupiter covering the δ of Cancer at dawn.

4) Saturn observed "two units below" the γ of Virgo.

Let us point out that we found no reason to doubt the correctness of modern identifications of the Ptolemaic stars.

Let us consider each of these four events separately.

3.2.1 The η of Virgo covered by Venus in 960 A.D.

Bear in mind that Ptolemy's text is as follows: "Among the ancient observations we have chosen one, described by Timocharis in the following manner: in the 13th year of Philadelphus, on the 17th-18th of the Egyptian Messor, in the 12th hour, Venus completely covered the star located on the opposite of Vindemiatrix" ([1355], page 319, Chapter X.4).

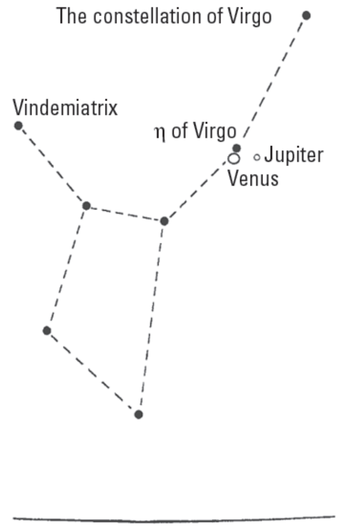


Fig. 10.3. Venus covering the η of Virgo shortly before dawn on 18 October 960 A. D. The observation location that we chose corresponds to Alexandria and Cairo in Egypt. The calculations were made with the aid of the PLANETUP program. We see the local horizon of Alexandria for 5 AM local time. The Sun is below the horizon, at the distance of some 40 degrees from Venus.

The solution we came up with using the middle element method is as follows: Venus covered the η of Virgo in October 960 A.D., which corresponds perfectly to the year 476 from Nabonassar, qv in fig. 10.2. This covering that took place in the morning of 18th October 960 is ideal. The distance between Venus and the star equalled 1-2 minutes, which would make the star invisible due to the radiance of Venus.

At the same time, it has to be pointed out that the covering of the η of Virgo by Venus is an event as frequent as it is uninformative. One would wonder why such an ordinary celestial event would be mentioned by the ancient astronomer and included in the Almagest. A possible answer is implied by fig. 10.3 where we see Venus covering the η of Virgo in 960. It turns out that Jupiter was rather close to Venus that moment – at the distance of some 10 minutes. In other words, Venus covered the star while its position all but coincided with that of Jupiter. This fact is remarkable

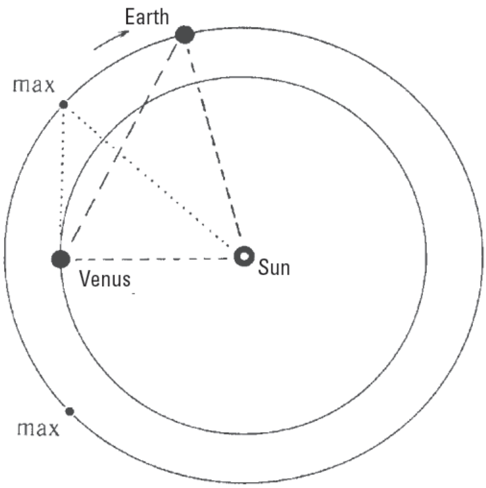


Fig. 10.4. Respective positions of Venus, the Sun and the Earth for the morning of 18 October 960 A. D. Calculated in PLANETUP. Venus had reached its maximal elongation shortly before.

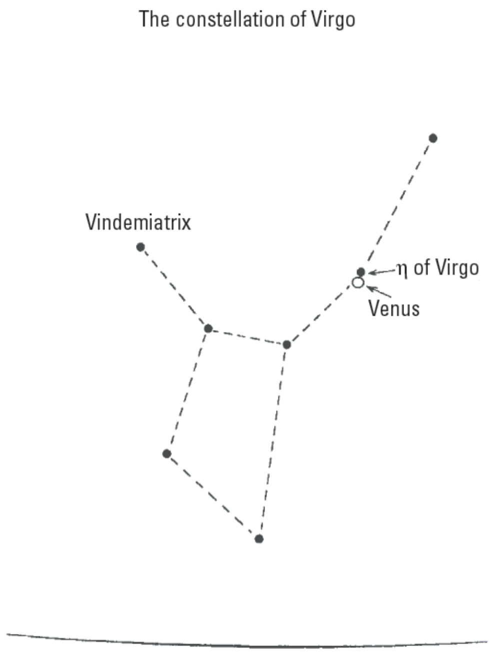


Fig. 10.5. Venus covering the η of Virgo shortly before dawn on 21 October 888 A. D. The observation location that we chose corresponds to Alexandria and Cairo in Egypt. Calculated in PLANETUP. We see the local horizon of Alexandria for 5 AM local time. The Sun is below the horizon, at the distance of more than 40 degrees from Venus.

enough to have attracted the attention of the ancient astronomer who decided to mention Venus covering the star under such rare circumstances.

By the way, the 960 covering of a star by Venus also corresponds to Ptolemy's claim that "Venus had already been past its maximal matutinal elongation" ([1355], page 319); qv in fig. 10.4. Bear in mind that the maximal elongation point of a planetary orbit is the point where the planet in question is at the maximal distance from the sun as observed from the Earth. The solar and telluric vectors of the star give a right angle.

Let us now consider the "misprint version" for Venus. The previously-discovered middle element solution is as follows: Venus covered the η of Virgo in September 887 A.D. The η of Virgo is usually identified as the Ptolemaic "star on the opposite of Vindemiatrix" that we are referring to.

A more precise calculation made with the aid of the PLANETUP software ([1405:1]) demonstrates that Venus had indeed covered the η of Virgo completely on the 9th of September 887 A.D., at 16:12 GMT. However, the visibility conditions of this covering have been rather poor in Europe, qv below.

However, Venus frequently passes near the η of Virgo, covering it completely in many cases. It is little wonder that another solution exists for Venus, one that is rather close to the first one temporally and happens to be ideal.

On the 21st October 888 A.D. Venus passed the η of Virgo at the distance of less than 5 arc minutes at about 1 AM GMT, or 3-4 AM for Eastern European longitudes. The comparative luminosities of Venus and the η of Virgo differ by 8 stellar magnitudes ($M = -3.4$ for Venus and $M = 3.89$ for the η of Virgo). Such a drastic difference in luminosity may have made 5-minute proximity look like perfect covering, since the dim star would be outshone by the brightness of Venus that approached it rather closely (see fig. 10.5).

Astronomical visibility conditions for the covering of the η of Virgo by Venus were outstandingly good on the 21st October 888. In Alexandria, for instance, Venus rose around 3 AM local time (1 AM GMT). In the Volga region the time was 4 AM. The sun rose three hours later; therefore, one may have observed Venus covering the η of Virgo for three hours before sunrise.

Let us point out that a slight shift of the covering date for Venus forwards (888 A.D. instead of the initially calculated 887 A.D.) affects the mediaeval solution that we come up with for Venus in a positive way, making the chronological concurrence with the Almagest descriptions better. This is plainly visible from fig. 10.2.

Let us briefly discuss the initial solution that we got for Venus (the evening of the 9th September, 887 A.D.)

According to the PLANETUP software ([1405:1]), the 887 A.D. covering was precise even when observed through a 25x telescope – in other words, Venus would continue covering the η of Virgo even if magnified by a telescope. This covering lasted for an hour – between 15:00 and 16:00 GMT. However, the visibility conditions were poor due to the close proximity of Venus to the sun.

On the other hand, the more precise solution of 888 A.D. for Venus conforms to Ptolemy's description perfectly well. One could observe Venus covering the star at any latitude in 888.

As for the time of observation indicated in the Almagest as "the twelfth hour", it can be said to fit Venus well at any rate, since Venus is never too far away from the sun and can be observed around either 6 PM or 6 AM local time – at or around either the dawn or the dusk. The Almagest indicates the "twelfth hour"; bear in mind that in the Middle Ages time was often counted from 6 AM or 6 PM – the vernal (autumnal) dusk or dawn. Both the sunrise and the sunset would thus take place at roughly twelve o'clock as opposed to the six o'clock in either the morning or the evening in modern interpretation.

3.2.2. Mars covering the β of Scorpio in 959 A.D.

Ptolemy's text runs as follows: "We considered one of the old observations, which makes it clear that in the 13th year of Dionysius, on the 25th of Aigon, Mars covered the northernmost star on Scorpio's forehead in the morning" ([1355]), page 342, Chapter X.9).

The solution we have previously found with the middle element method is as follows: the covering of the β of Scorpio ("the northernmost star on Scorpio's forehead") by Mars took place in February 959 A.D., qv above.

More precise calculations made with the aid of the PLANETUP software ([1405:1]) tell us the following. In 959 A.D., on the night of the 13th-14th February, Mars passed by the β of Scorpio, the distance between them equalling circa 15 arc minutes. The modern formulae of the French astronomers J. Simon and P. Bretagnon have been used by M. Y. Polyakov for additional calculations at our request. These calculations also confirmed the distance between Mars and the star in question to have equalled some 15 arc minutes that night, qv in fig. 10.6.

We might encounter the objection that such propinquity between Mars and the star cannot be considered an exact covering, since a person with keen eyesight is capable of distinguishing between two stars at this distance. Let us however point out that in case of Mars Ptolemy does not use the phrase "completely covered" as he does in his description of the Venus covering, simply telling us that "Mars covered the star". Is Ptolemy's choice of words arbitrary in this case? Let us consider all four coverings (see table 10.2).

Let us recollect that the coordinates of all the stars

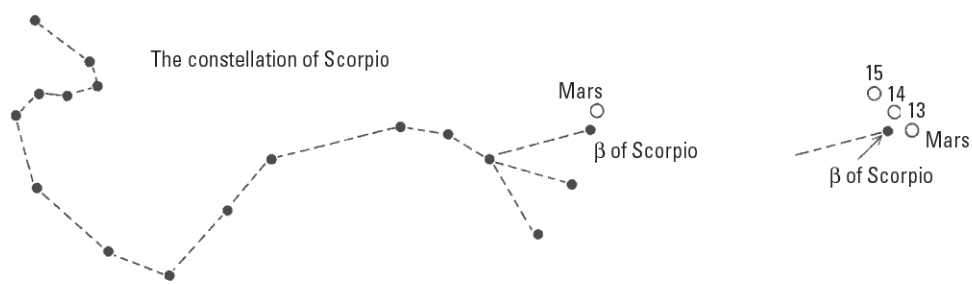


Fig. 10.6. Mars covering the β of Scorpio on the night of 13-14 February 959 A. D. On the right we see the position of Mars in relation to the β of Scorpio for the morning of the 13, 14 and 15 February indicated separately. Calculated in PLANETUP.

in the Almagest star catalogue are rounded off to 10'. In other words, the measurements of stellar coordinates in Ptolemy's epoch were made with the measurement unit value of circa 10'. This very distance must have therefore been the "unit" that Ptolemy refers to. We see a very good concurrence of Ptolemy's text with the astronomical solution that we found – namely, the fact that the distance of 25' between Saturn and the star was estimated as equalling "two units" by Ptolemy. This is high precision for a naked eye observation.

Our mediaeval astronomical solution for the planetary coverings of the stars mentioned in the Almagest is presented as table 10.2. This table implies the following:

1) A "unit", or the measurement unit used in the Almagest, roughly equals 10-15 arc minutes, which is very close to the Ptolemaic coordinate grid measurement unit value in the star catalogue.

2) The proximity of 10'-15' between a star and a planet (one unit) is referred to as a "covering" in the Almagest (qv applied to Mars and Jupiter).

3) The proximity of 1'-2' is naturally referred to as an "complete covering" in the Almagest, since even an observer with exceptionally keen eyesight could not see the rather dim star at such a small distance from the extremely bright Venus.

It is therefore obvious that Ptolemy's choice of expressions ("covering" and "complete covering") is far from arbitrary. They refer to the following: a "complete covering" means that two luminous dots on the sky cannot be told apart in case of a naked eye observation. A simple "covering" implies that the distance between the luminous dots is comparable with the measurement unit (which equals 10' for the Almagest).

Bear in mind that Ptolemy tells us that the Mars covering took place in the morning, which corresponds perfectly to the astronomical environment of 959 A.D. Mars only rose after midnight local time this year at the longitudes of Alexandria and Eastern Europe. The covering could therefore only be seen in the morning, or after midnight, which is what the Almagest tells us.

3.2.3. Jupiter covering the δ of Cancer in 994 A.D.

Ptolemy's text tells us the following: "We have once again considered a very accurate old observation telling us that in the 45th year of Dionysius, on the 10th of Parthenon, Jupiter covered the Northern Asse" ([1355], page 361, Chapter XI.3).

The solution that we found earlier using the middle element method is as follows: in July of 994 Jupiter really passed by the δ of Cancer at the distance of circa 20'.

More precise calculations with the aid of the PLANETUP software ([1405:1]) confirm the fact that Jupiter did indeed pass the δ of Cancer at the distance of some 15 arc minutes, qv in fig. 10.7.

Pay attention to the fact that Ptolemy emphasises

The covering of a star by a planet as described by Ptolemy in the Almagest	*Calculated distance between the planet and the star at the moment of observation*	*The date*
Venus "covered the star completely"	1' – 2'	The morning of the 18th October, 960 A.D.
For the "misprint version"	Less than 5'	888 A.D., 21st October
For the "misprint version"	Less than 1'	9th September, 887 A.D. (poor observation conditions)
Mars "covered the star"	15'	The morning of the 14th February 959 A.D.
Jupiter "covered the star"	15'	The dawn of the 25th July 994 A.D.
Saturn was at the distance of "two units" from the star	25' – 30'	The evening of the 16th August 1009 A.D.

Table 10.2. Mediaeval solution of the X-XI century for the coverings of stars by planets as described in the Almagest.

that Jupiter had covered the star at dawn. Indeed, on the 25th of July 994 Jupiter rose above the horizon just one hour before sunrise; therefore, the covering of the star in question by Jupiter could only be seen at dawn, which is meticulously pointed out by Ptolemy.

Once again we see that the time of day Ptolemy specifies for the planetary covering of the star concurs very well with our mediaeval solution, as is the case with Venus and Mars.

3.2.4. Saturn approaching the γ of Virgo in 1009 A.D.

The Ptolemaic text is as follows: "We have considered yet another accurate observation of old, according to which Saturn was located two units below the southern shoulder of Virgo on 5 Xanticus of the Chaldaean year 82" ([1355], page 379, Chapter XI.7).

The solution we found before using the middle element method tells us that in August of 1009 A.D. Saturn passed the γ of Virgo at the distance of less than 50', being below the star in question.

More precise calculations conducted with the aid of the PLANETUP software demonstrated that Saturn did indeed pass the γ of Virgo at the distance of some 25-30 arc minutes on the 16th August 1009 A.D., qv in fig. 10.8.

Why does Ptolemy refer to a distance of "two units" in this case? We have already seen that the proximity of 15 arc minutes between a star and a planet is called a "covering" in Ptolemy's text, as is the case with Mars and Jupiter. The distance is two times as great in case of Saturn, equalling circa 30 minutes. Ptolemy deems this distance to equal "two units"; therefore, a single "unit" is approximately equal to 10-15 arc minutes. If the distance between a star and a planet equals one such unit, Ptolemy calls it a "covering"; should there be several such units between the planet and the star in question, Ptolemy tells us just how many units comprise the distance. In case of an observable superimposition of a planet over a star, Ptolemy uses the term "complete covering".

As is the case in all of the examples listed above, Ptolemy indicates the time of day with the utmost precision if we are to adhere to our mediaeval X-XI century solution. Namely, Saturn set below the horizon a single hour later than the sun on the 16th August 1009. Therefore it could only be seen in the evening, right after dusk, having disappeared below the horizon immediately afterwards. It could actually be observed below the star in relation to the local horizon line in Alexandria, just as Ptolemy tells us (fig. 10.8).

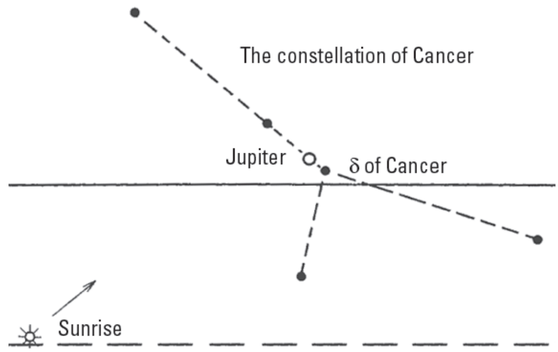


Fig. 10.7. Jupiter covering the δ of Cancer on 25 July 994 A.D., observed at dawn. We chose Sebastopol in Crimea as the observation point. Calculated in PLANETUP. The continuous line represents the local horizon at 1:30 GMT (the rising of Jupiter), and the dotted one stands for the local horizon at 2:30 GMT (sunrise).

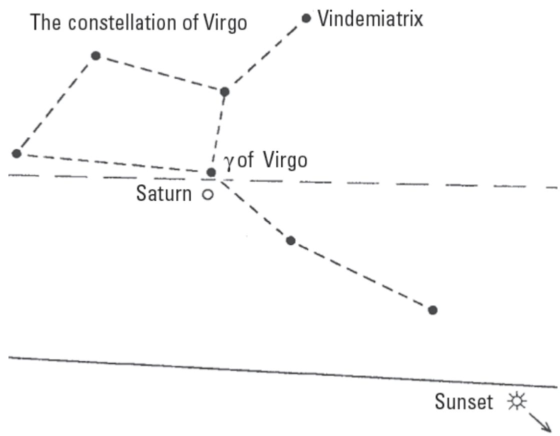


Fig. 10.8. Saturn passing under the γ of Virgo at the distance of "two units" (or 30 arc minutes) in the evening of 16 August 1009 A. D. Sebastopol in Crimea was chosen as the observation point. Calculated in PLANETUP. The continuous line represents the local horizon at 16:40 GMT (for the moment of sunset), and the dotted line represents the same at 17:50 GMT (for the moment that Saturn had set). Sunset followed the setting of Saturn by an hour; therefore, the planet could only be seen in the evening.

Therefore, this mediaeval solution corresponds to each and every Ptolemaic indications concerning the observation conditions in this last case as well.

As for the "Scaligerian" solution of the III century B.C., Jupiter, for instance, could be seen near the δ of Cancer all night long, which makes the ancient author's indication that Jupiter covered the star "at dawn" bizarre – or unnecessary at the very least. The same is true for Saturn, which could be observed near the star all night long and not just in the evening, as is the case in our solution. The Almagest explicitly tells us that Saturn had approached the star in the evening. Our solution is therefore in better correlation with the ancient descriptions cited by Ptolemy than the Scaligerian version.

Corollary. It turns out that the mediaeval solution that we have discovered, namely:

- 18 October 960 A.D. for Venus (21 October 888 A.D. or 9 September 887 A.D. in case of the "misprint version", the latter solution being less fitting);
- 14 February 959 A.D. for Mars;
- 25 June 994 A.D. for Jupiter, and
- 16 August 1009 for Saturn

corresponds to all of the descriptions provided by Ptolemy perfectly, even the ones we paid no attention to before, in our approximated calculations (such as "in the morning", "at dawn" etc). This serves as additional evidence in support of the statement that the Almagest contains the descriptions of astronomical events that took place in the epoch which cannot possibly predate the IX-XI century A.D.

However, let us reiterate that one needs to be aware that such precision of planetary coverings of stars (around 15 minutes) could be obtained by calculations using the Kepler theory in the XVII century. In Chron6 we cite the data concerning false datelines in many books of the alleged XVI century which were really published in the XVII century and contain a false earlier dating. This fact makes us uncertain of whether the version Almagest that we have at our disposal nowadays really dates to the XVI century. It is very possible that the Almagest version known to us nowadays was created in the XVII century, in which case it may contain the results of astronomical calculations made in accordance with Kepler's theory. These "calculated" astronomical events may be referred to as actual observations in the Almagest, which is detrimental to the value of "planetary covering datings", since one cannot help suspecting these coverings to have been *calculated* as late as the XVI-XVII century in order to fit the Scaligerian chronology, which is the case with several other "ancient astronomical observations", or even with the purpose of "confirming" it, since the freshly-fabricated Scaligerian chronology had been in dire need of "documental proof" in the XVII century. Such proof was hastily produced via the "correct editing" of such authentic old documents as the Almagest.

Such suspicions do not concern the Almagest star catalogue, which we demonstrate to be a really old document compiled with the use of the X-XI century observations above.

3.2.5. The chronology of the Almagest according to the X-XI century solution

According to the dating of the planetary coverings resulting from the X-XI century solution, the beginning of the Nabonassar era as reflected in the Almagest dates to 480-490 A.D. More precisely, the polar values of this era beginning for which we have strict correlations between the calculated and Ptolemaic datings of the coverings in question are 483 and 492 A.D., respectively (see table 10.1 above which contains Ptolemaic datings of the coverings that use the Nabonassar era).

Let us point out the most noteworthy fact that 492 A.D. is exactly the year 6000 by the Byzantine era "since Adam", which was used extensively up until the XVII century. In particular, it had been used in Russia and Byzantium before the Anno Domini era was introduced in the XVI-XVIII century. What would make the year 6000 in this chronology important to us? Firstly, this is a good round figure divisible by 1000 years, which would make it a natural simplification of the chronological initial reference point. Millennia would often be omitted from mediaeval datings, qv in Chron1. Therefore "year zero" of the Byzantine era "since Adam" was de facto the year 6000 up until the end of the XV century, or 492 A.D. Secondly, the birth of Christ is dated to this very year in some of the old chronicles. We must make the observation that Christ is apparently referred to as "the celestial king" (or "Nabo-na-sar") in the Almagest,

although the author (editor) of the Almagest is likely to have not been aware of this. Said year is used for the dating of Christ's birth by the mediaeval Byzantine chronicler John Malalas ([338] and [503]). His ***Chronograph***, which had been a very widely-distributed work in the Middle Ages and whose Slavic and Greek copies had reached our day, tells us that "everyone is of the opinion that the Lord's advent took place in the year 6000" ([503], page 211). In other words, John Malalas dates the advent of Christ to the year 6000. If we are to convert this dating into modern chronology, we shall come up with 6000 – 5508 = 492 A.D. Malalas tells us that everyone adhered to this opinion, which goes to say that the dating of Christ's birth to the year 6000 since Adam, or 492 A.D., was a common one in his epoch.

This would make the year 492 as the initial reference point of the Almagest chronology a natural choice. If the Almagest dates to the late Middle Ages, this is the chronological concept that we should expect either Ptolemy himself or the editor of the book to hold true.

The initial reference point of Nabonassar's era allows us to reconstruct the chronology of the Almagest in general. One has to make the important observation here that a study of the chronology reflected in the Almagest texts that had reached our day is really a reconstruction of the opinion of the XVI-XVII century editor who had made the Almagest look the way it does today and not the opinion of the ancient XI-XIII century authors who had created the first versions of the Almagest, and its star catalogue in particular. Nevertheless, this later chronology can also be of interest to us. The chronological version of more recent editors may still be at odds with the consensual Scaligerian version since in the epoch of the XVI-XVII century, when the final editions of the Almagest were made, the authority of the Scaligerian chronology was only beginning to establish itself. Other chronological schemes of the XIV-XV century had also been in use at the time, and we hardly know anything about those nowadays. Those versions differed from the Scaligerian version considerably; below we shall witness this to be the case with the Almagest.

The era of Nabonassar is the standard era used in the Almagest, which occasionally refers to it simply as to the "initial epoch" ([704], page 130). All the other eras and chronological landmarks mentioned by Ptolemy are dated in relation to Nabonassar's era in the Almagest. We encounter the following era and reign datings in the Almagest:

The first year of Mardokempad's reign = the 25th year of Nabonassar ([704], pages 129, 130, 126 and 200).

The first year of Nabopallasar = the 123rd year of Nabonassar ([704], page 161).

The first year of Cambyses = the 219th year of Nabonassar ([704], page 161).

The first year of Darius = the 226th year of Nabonassar ([704], pages 128 and 129).

The reign of Phanostratus, the Archon of Athens = the 366th year of Nabonassar ([704], page 132).

The reign of Evandrus, the Archon of Athens = the 367th year of Nabonassar ([704], page 133).

The beginning of the 76-year period of Calippus = the 418th year of Nabonassar ([704], pages 133, 80, 81, 182, 216, 133, 182 and 222).

The first year of the era counted from the death of Alexander = 425th year of Nabonassar ([704], pages 99-100, 80, 336-337 and 349-351). It is usually considered that the Alexander in question is Alexander the Great, however Ptolemy simply mentions "Alexander" by name. According to the Almagest, "424 Egyptian years passed between the beginning of Nabonassar's reign and the death of Alexander" ([704], page 99). According to Ptolemy, there are 365 days in an Egyptian year ([704], page 80).

The first Chaldaean era year = the 438th year of Nabonassar ([704], page 305). Modern commentators are of the opinion that the "Chaldaean era" of the Almagest is really the so-called "Seleucidean era" ([704], page 595). However, Ptolemy himself does not use this name and always refers to the "Chaldaean era".

The first year of Philadelphus = the first year of the Dionysian era = the 464th year of Nabonassar ([704], pages 304, 305, 321-322 and 336-337).

The first year of Philometor = the 568th year of Nabonassar ([704], page 181).

The first year of Augustus = the 719th year of Nabonassar ([704], pages 99-100).

The first year of Domitian = the 829th year of Nabonassar ([704], page 220).

The first year of Trajan = the 845th year of Nabonassar ([704], page 331).

The first year of Adrian = the 863rd year of Nabonassar ([704], pages 99-100, 126, 157, 326 and 340).

The first year of Antoninus = the 884th year of Nabonassar ([704], pages 139-140, 80, 216, 311, 326 and 340).

The text of the Almagest dates the firsthand astronomical observations (which are supposed to have been made by Ptolemy himself) to the epoch of Antoninus, qv on page 311 of [704], for instance. The text of the Almagest is as follows: "we observed Mercury in the second year of Antoninus, or the 886th year of Nabonassar" ([704], page 311, section IX.9). Another passage we encounter in the Almagest tells us that "the most precise observations of the equinoxes and the summer solstice were conducted by us in the 463rd year since the death of Alexander" ([704], page 91, section III.3).

The observations of Hipparchus, for instance, are dated to the year 197 since the death of Alexander in the Almagest, or the year 621 of Nabonassar ([704], page 142). The text of the Almagest tells us the following: "Hipparchus writes that he used instruments to observe the Sun and the Moon on Rhodes in the 197th year since the death of Alexander" ([704], page 142, section V.5). One must naturally bear in mind that the final datings are most likely to have been introduced into the text of the Almagest in the XVI-XVII century. It is possible that this Hipparchian observation of the sun and the moon with the use of instruments was really made by Tycho Brahe in the late XVI century which was ascribed to the "ancient Hipparchus" in the final edition of the Almagest.

In accordance with the above, let the year 492 A.D. stand for the year 6000 "since Adam" in the old Russian and Byzantine chronology. We shall come up with the following datings for the chronological landmarks of the Almagest:

The first year of Nabonassar's era – 493 A.D.

The first year of Mardokempad – 517 A.D.

The first year of Nabopallasar – 615 A.D.

The first year of Cambyses – 711 A.D.

The first year of Darius – 718 A.D.

The archonship of Phanostratus – 858 A.D.

The archonship of Evandrus – 859 A.D.

The first year of the first cycle of Calippus – 910 A.D.

The death of Alexander – 916 A.D.

The first year of the Chaldaean era – 930 A.D.

The first year of Philadelphus – 956 A.D.

The first year of the Dionysian era (era of Philadelphus?) – 956 A.D.

The first year of Philometor – 1060 A.D.

The observations of the sun and the moon made by Hipparchus – 1113 A.D.

The beginning of Augustus' reign – 1211 A.D.

The first year of Domitian – 1321 A.D.

The first year of Trajan – 1337 A.D.

The first year of Adrian – 1355 A.D.

The first year of Antoninus – 1376 A.D.

The observations of the equinoxes made by Ptolemy – 1379 A.D.

The actual observations of Ptolemy ascribed to the epoch of Antoninus are thus dated to 1370-1380 A.D. in the Almagest. The abovementioned observation of Mercury ([704], page 311) is dated to 1378, for instance. The observations of the equinoxes and the solstice ([704], page 91) are dated to 1379, or the end of the XIV century. The observations of Hipparchus are dated to rougly 1113 A.D., or the beginning of the XII century. We can see that the last editors of the Almagest had a concept of chronology that was completely different from the Scaligerian version (which dates Hipparchus to the II century B.C., for instance).

We have to point out that the resulting chronology of the Almagest concurs well with that of the famous mediaeval author Matthew Vlastar ([518] and [17]). See CHRON6 for our study of Vlastar's chronology. The work of Matthew Vlastar is presumed to have been written in the XIV century ([17], page 18). We see that the Almagest in general corresponds quite well with the chronological tradition of the XIV-XVI century.

The picture of the chronological concepts that the authors and the editors of the Almagest adhered to (fig. 10.9) is in ideal correlation with our dating interval of the Almagest star catalogue (600-1300 A.D.). Indeed, fig. 10.9 demonstrates this interval to include the planetary coverings of the stars as well as a manifest mass concentration of the Almagest's chronological reference points. In particular, the possible dating interval of the Almagest star catalogue covers the initial counting point of the Calippus cycles, the beginning of the era starting with the death of Alexander, the beginning of the Chaldaean era and the beginning of the Dionysian era. Four out of five eras

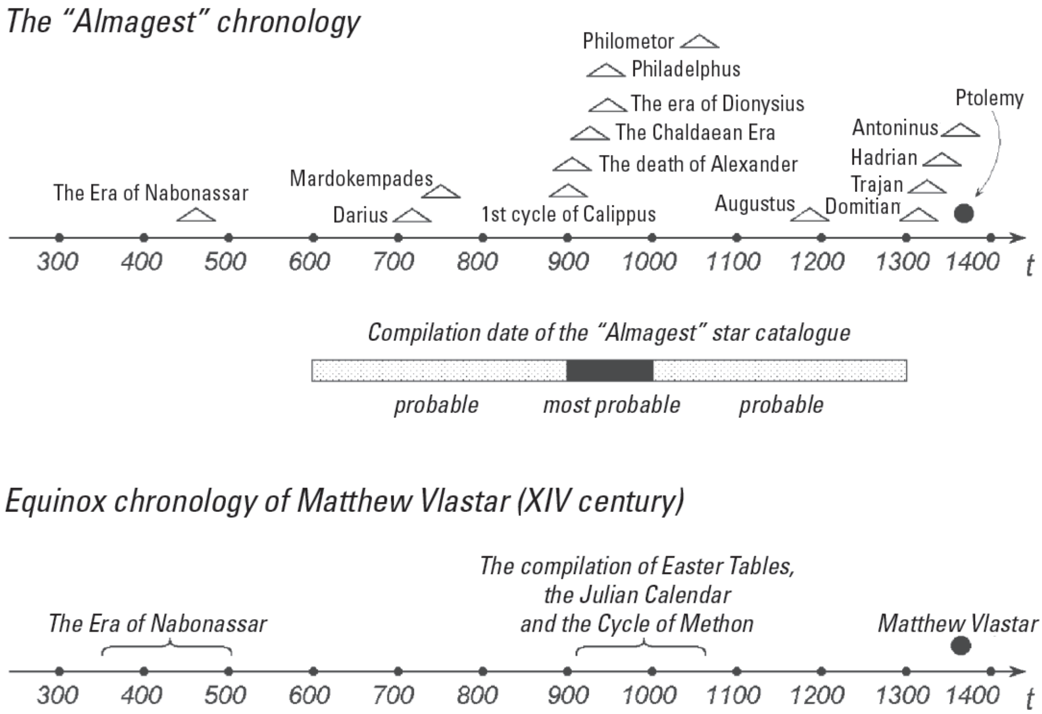


Fig. 10.9. The chronology of the "Almagest" in accordance with the mediaeval solution obtained from the coverings of stars by planets and shifted into the X-XI century, which makes the beginning of the Nabonassar era shift into the second half of the V century A.D. We provide another chronology for comparison – a very uninformative and rudimentary version suggested by the Byzantine author Matthew Vlastar, whose works are usually dated to the XIV century. We see a correspondence between the two chronologies in question.

used in the Almagest, in other words, excepting the era of Nabonassar.

Furthermore, all of the Roman emperor reigns mentioned in the Almagest (those of Augustus, Antoninus, Adrian, Trajan and Domitian) become dated to the epoch of the XIII-XIV century A.D. according to fig. 10.9. This is the very epoch that follows the compilation of the Almagest star catalogue, which is when the first "ancient" versions of the Almagest are most likely to have been edited and expanded. Those were based on the initial "royal" star catalogue of the XI century.

We must also note that the date of "Alexander's death" is roughly 916 A.D. according to fig. 10.9. The resulting date corresponds perfectly to the reign of the only emperor with the name of Alexander in the entire history of Byzantium and mediaeval Europe – 912-913 A.D. ([495], page 18).

Let us also point out that the rough dating for the beginning of the Calippus cycle chronological scale is 910 A.D. according to fig. 10.9. It is rather close to the beginning of the Great Indiction calendar in 877 A.D., although the difference is far from being marginal and equals some 35 years. Bear in mind that the beginnings of the Great Indictions are separated by 532-year intervals in the Julian calendar, which is the cycle period after which the combination of the mediaeval calendarian characteristics of a year (the Indiction, the circle for the Moon and the circle for the Sun) begins to repeat itself. See more details in our study of the calendar issues contained in CHRON2 and CHRON6. Apart from the Great Indiction, the calendars also used a shorter 76-year period – the so-called cycle of Calippus. Bear in mind that a Great Indiction consists of seven cycles of Calippus, which is an integer. Indeed, 532/76 = 7. If the "ancient"

Greek cycle of Calippus comprised a subsection of the Great Indiction, each of the latter should begin at the same time as the first cycle of Calippus. The approximate Calippus cycle beginning date of 910 A.D. does not contradict this. The difference of 911 – 877 = 34 years is marginal compared to the 532 years of the Great Indiction. However, a cycle of Calippus does not necessarily have to begin at the beginning of the Indiction.

However, it isn't quite clear why the cycle of Calippus beginning in 910 A.D. does not correlate with the Paschalian 19-year "circle for the Moon", or the cycle of Methon. According to the Paschalian tables, the circle for the Moon equalled 15 and not 1 in 910 A.D., qv in Chapter 19 of CHRON6. The cycle of Calippus and the Paschalian lunar cycle begin to correlate with each other if we are to presume that what we're dealing with here is a 100-year shift in the Almagest chronology which moved the XI century events backwards into the X. This phantom reflection is present and indeed well-manifest in the Scaligerian version, qv in CHRON1. A centenarian shift transforms 910 into 1010, which is the exact first year when the 19-year Paschalian "circle for moon" begins.

The suspicion that there is a 100-year shift present is also backed up by the following fact. The Almagest contains numerous references to the era of Dionysius whose beginning coincides with that of the Philadelphus' reign (956 A.D., qv above). However, the Dionysian era was the mediaeval name used for the Anno Domini era. For instance, in the early XVII century "Kepler dated his ***New Astronomy*** as follows: *Anno aerae Dionisianae 1609* [or the 1609th year of the Dionysian era – Auth.]" ([393], page 248). A propos, this name of the A.D. era is explained by the fact that the monk who was the first to have calculated the year of Christ's birth is presumed to have been called Dionysius ([393], page 240). However, another explanation is also possible. The actual word "Dionysius" stands for "god" or "divine" in Latin; the era of Dionysius is therefore the era of the Lord, or the Anno Domini era.

Furthermore, according to the New Chronology, Christ was born around 1152 A.D., qv in our books entitled "King of the Slavs" and "The Foundation of History". The Crucifixion took place in 1185 A.D. However, later chronologists of the Middle Ages miscalculated the birth of Christ by 100 years initially, shifting the date in question into the XI century. The error was aggravated by a further shift of 1050 – to the beginning of the New Era. Vestiges of the erroneous mediaeval tradition of dating the Nativity to circa 1050 A.D. have survived until our day and age – for instance, if we are to believe the indications given by mediaeval sources concerned with the Passover and the calendar, the alleged year of the Crucifixion is 1095 A.D., qv in Chapter 19 of "Biblical Russia".

Let us now consider the Almagest chronological landmark table cited above. It gives us a single isolated chronological landmark for the period of the XI-XII century, which is the reign of Philometor. According to the chronology of the Almagest, this reign begins almost exactly a hundred years after Dionysius (or Philadelphus). This falls on the year 1060 A.D. according to our table, which is very close to the first erroneous dating of the Nativity (the XI century, according to the learned chronologists). The reign of Philometor ends in the 631st year of Nabonassar according to the Ptolemaic ***Canon of the Kings*** ([704], pages 458-459), or 1093 A.D. by our table. Once again, we see that this date all but coincides with 1095 A.D., or the first erroneous dating of the Crucifixion. By the way, historians are of the opinion that Philometor was named Ptolemy, likewise Philadelphus ([704], pages 458-459). The Ptolemaic ***Canon of the Kings*** contains three "divine" names of Ptolemaic kings that follow Philometor immediately: king Evergetoy *Dey*teroy (*Dey* = God), king *Soteros* (*Soter* = Saviour), and king *Dio*nysoy Neoy (*Dio* = God), qv in [704], pages 458-459. We see no other royal names containing the root "god" or "saviour" anywhere else in the ***Canon of the Kings*** ([704], pages 458-459). This is the only such fragment in the entire ***Canon of the Kings***.

It is therefore possible that the A.D. era is referred to as the Philometor era in the Almagest. It is duplicated as the Dionysian era after a 100-year shift backwards, and is also known as the era of Philadelphus.

Let us conclude this section with an observation concerning the beginning of the Nabonassar era which is dated to the V century A.D. according to fig. 10.9. Let us emphasize that the use of an era beginning in the V century A.D. in the Almagest by no means implies the existence of a continuous astronomical tradition between the V century and Ptol-

emy's epoch. According to CHRON7, people are most likely to have known no literacy in the V century. The matter is that the stable chronological reference points were often introduced as events with an a priori calculated date, just like they are today. On the other hand, the eras that begin with a current event which is well-dated initially, were seldom used for hundreds of years, being too closely-tied to contemporaneity and subject to being replaced by new ones with the change of generations. A good example is an era counted from the beginning of a living emperor's reign. Such eras are still used in Japan, changing every time that a ruler dies.

The "long-term" eras most probably resulted from chronological calculations of the datings of important events in distant past, already with no connections to contemporaneity and unlikely to make the subsequent generations want to replace them with new ones. It is a well-known fact that the modern Anno Domini era, for instance, came to existence in this manner. This is the era whose beginning was calculated, and we have been using it for the last couple of centuries. The era "since Adam" (or Genesis) in its numerous versions, which was used in the XIV-XVII century, must have been introduced in a similar way. All these eras are based on the chronological calculations of events dating to the distant past, or *forgotten datings.* See our analysis of calendar issues in CHRON6, Chapter 19.

However, the mediaeval chronological calculations tend to contain enormous errors resulting from the poorly-developed science of the time as well as certain characteristics of the old calendar systems resulting in the "instability" of the latter. See more about it in CHRON6, Chapter 19. Coupled with the natural desire of the chronicler to date important events to as distant an era as possible ("the older, the better" principle), these errors often gave birth to extremely ancient chronological reference points in the past, which would then be considered the beginning of an era and used to tens and hundreds of years on end, as is the case with the Anno Domini era which we already cited.

Therefore the several chronological landmarks located at some distance from the XI-XIV century epoch as seen in fig. 10.9 (the beginning of the Nabonassar era, the reigns of Mardokempad and Darius etc) are most likely to result from different erroneous chronological calculation of the XIV-XVII century, which would obviously manifest in the Almagest.

Let us also pay attention to the resulting datings of the reigns of the Roman emperors who were Ptolemy's contemporaries and got mentioned in the Almagest. They are Domitian, Trajan, Adrian and Antoninus. All of these reigns date to the end of the XIV century, qv in fig. 10.9, while Ptolemy himself (the author of the Almagest) winds up in the late XIV century – the epoch of the Kulikovo battle.

The conclusion we can make in this respect is as follows. The mediaeval datings of the planetary coverings of stars correspond perfectly with the dating of the Almagest star catalogue as calculated above, and make the epoch when the main part of the Almagest was created fall upon the XII-XIV century A.D., qv in fig. 10.9. The imperial reigns contemporary to Ptolemy and mentioned to the Almagest date to the end of the XIV century.

The resulting picture correlates well with our dating interval of the Almagest star catalogue. As we have already pointed out, the catalogue is most likely to be the oldest part of the Almagest, and the remaining text was added thereto. This text must have transformed into the fundamental astronomical tractate by the end of the XIV century. It would then be edited and developed up until the XVI-XVII century which is the epoch when the Scaligerian version of chronology was created. The final version of the Almagest must have been tailored to fit the Scaligerian chronology already in Kepler's epoch. However, it also contains traces of older chronological concepts dating to the XIV-XVI century. This is how the Almagest looks today.

3.3. Discussing the late mediaeval solution of the XV-XVI century

This solution is of interest to us since it falls into the epoch of the first editions of the Almagest. It is presented in fig. 10.10.

3.3.1. The η of Virgo covered by Venus in 1496 A.D.

Venus covered the η of Virgo around 4 PM GMT on the 19th September 1496, the covering being ideal since the distance between Venus and the star in question equalled 1 minute. However, this covering was neither observable in Europe, nor in Asia. It could

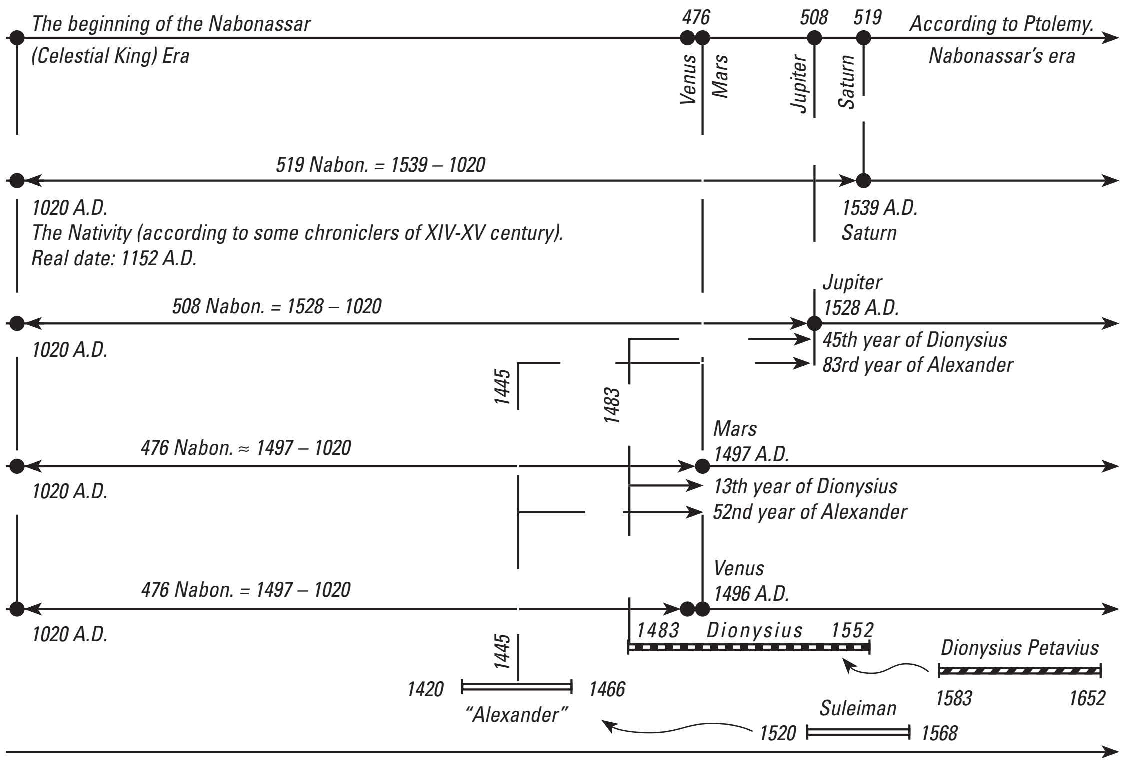


Fig. 10.10. The chronology of the Almagest in relation to the late mediaeval dating of the four planetary coverings of the stars. These coverings were possibly observed in the XV-XVI century. However, in this case the Ptolemaic "Era of Nabonassar" is nothing but the Anno Domini era, which may have been counted from 1020 A.D. in certain documents, according to our reconstruction. The diagram also demonstrates how the eras of Dionysius and Alexander may have come into existence.

only be seen from the Pacific region and Alaska. Nevertheless, an observer located in Alexandria who was watching Venus approach the star on the morning of the 19th September and move away from the star on the morning of the 20th September may well have calculated the exact moment of the almost complete covering, namely, 16:00 GMT, or around 18:00 local Alexandria time. Bear in mind that in the Middle Ages one would often begin to count the day from 6 PM; therefore, 6 o'clock in the morning and 6 o'clock in the afternoon as we understand them today would be referred to as "12 o'clock" back in the day. Therefore the moment that Venus covered the star completely around 18:00 Alexandria time on the 19th September 1496 is in ideal correspondence with Ptolemy's indication that Venus covered the star completely in the twelfth hour ([1355], page 319, Chapter X.4).

Calculations this precise are hardly phenomenal for the end of the XV century.

In the moment of the covering on 19th September 1496 Venus had indeed already been past its maximal morning visibility elongation, which is exactly what Ptolemy tells us. Maximal elongation was passed in the end of March 1496.

3.3.2. Mars covering the β of Scorpio in 1497 A.D.

Mars covered the β of Scorpio at night and in the morning of the 19th January 1497. Ptolemy reports the covering to have been visible in the morning. The minimal distance between Mars and the star in question equalled some 13-14 minutes approximately at 1 AM GMT on the 19th of January 1497, or at 3 AM local time in Alexandria. The distance between Mars and the star equalled circa 15 minutes by the mo-

ment of sunrise in Alexandria. Sunrise at the longitude of Alexandria or Cairo, for instance, took place at 4:50 GMT. Mars rose above the horizon around midnight on the 18th-19th January, and remained in close proximity to the star all that night, approaching the β of Scorpio ever closer in its movement. Therefore, Mars covering the planet was visible perfectly well in the morning of 19th January 1497. The position of both Mars and the star in relation to the horizon is qualitatively identical to scheme drawn for the X-XI century solution as seen above.

In full accordance with Ptolemy's specifications, the interval between said coverings of stars by Venus and Mars does not exceed a single year. Indeed, the interval equals four months starting with 19th September 1496 (Venus) and ending with the 19th January 1497.

3.3.3. Jupiter covering the δ of Cancer in 1528 A.D.

Jupiter covered the δ of Cancer in the evening of the 7th March 1528, and remained in close propinquity with it all the following night, the distance between the two equalling some 25 minutes. The visibility of the covering was rather good on the evening of 7th March 1528, at dusk. The sun had set around 17:00 GMT at the longitude of Alexandria, whilst Jupiter in conjunction with the star had remained visible up until 17:40 GMT when it disappeared below the horizon. Thus, the covering of the star by Jupiter remained visible in the evening sky for a certain amount of time. The respective positions of Jupiter, the star and the horizon are qualitatively identical to scheme drawn for the X-XI century solution, qv above, the only difference being in the direction of Jupiter's motion vector.

Ptolemy tells us that Jupiter covered the star in the morning, which correlates well with our solution. One has to remember that the actual motion of Jupiter is rather slow, and it remains near a star for about 12 hours without changing its position visibly. In the present case, it had remained rather close to the star all night between the 7th and the 8th of March 1528. Therefore, on the morning of 8th March Jupiter rose being rather close to the star, just the way it had been the previous evening. It would naturally become invisible after sunrise; however, Ptolemy's reference to Jupiter having covered the star in the morning is absolutely correct, since this covering really took place in the morning and lasted all night between the evening of the 7th March and the morning of the 8th.

There is also the possibility that Ptolemy's text in its present form contains a misprint owing to the fact that the Latin for "after sunset" is *supremo sole*, whilst *sole primo* stands for "the dawn" ([237], page 937). It would suffice for the first two letters in the word *supremo* to become obscured, and one could easily read it as *premo* or *primo*. Sunset could easily turn into sunrise this way. The Slavic for "the setting" (of a planet) is *v zakhode,* and is also easy enough to transform into *voskhod* (sunrise).

3.3.4. Saturn approaching the γ of Virgo in 1539 A.D.

Saturn approached the γ of Virgo on the evening of 5th September 1539. This event could be observed in the evening, just as Ptolemy tells us. The distance between Saturn and the star roughly equalled 30 minutes, and could therefore be declared to equal "two units". Saturn and the star were observable quite well in conjunction on the evening of 5 September 1539, at sunset. The sun had set around 16:00 GMT at the longitude of Alexandria, and Saturn remained observable in conjunction with the star up until 16:40 GMT when it had set. The location of Saturn and the Star in relation to the horizon is qualitatively identical to the scheme for the X-XI century solution as presented above.

In full accordance with Ptolemy's report, Saturn was located below the γ of Virgo in relation to the local horizon.

3.3.5. Commentary to the late mediaeval solution

Our reconstruction makes the late mediaeval XV-XVI solution of the covering problem quite possible. We come up with the following hypothetical picture.

The astronomers of the XV-XVI century are most likely to have really observed the four cases of planets covering stars as described above – in 1496, 1497, 1528 and 1539, qv in fig. 10.10.

Several decades later, in the end of the XVI – beginning of the XVII century, the new version of history was spawned by a certain group of chronologists, historians and astronomers who based it on the erroneous "extended" chronology. The most active ones must have been J. Scaliger (1540-1609), D. Petavius

(1583-1652) and J. Kepler (1571-1630); one also has to point out that Kepler had exchanged a number of letters with Scaliger in which the two were discussing chronological issues. Real events of the X-XVII century would wind up in distant past as a result. This activity concerned the editing of the Almagest in particular; the necessary astronomical knowledge of planetary cycles had already been available, and so the four planetary coverings of stars mentioned above may well have travelled backwards in time as well.

The falsifiers may have discovered two "ancient" solutions when they used the astronomical theory of the XVI-XVII century for the calculation of old planetary covering dates, or just one. They may have decided to choose the more ancient solution of the two (X-XI A.D. and III B.C.) – the latter. The observations of the real XV-XVI century astronomers (Timocharis, etc.) were arbitrarily cast into deep antiquity together with the observers themselves, possibly under altered names.

We still have to find out which one of the real XV-XVI century astronomers could have transformed into the "ancient" Timocharis after a chronological shift of circa 1800 years, for instance. What could his real name have been? As for the "ancient" Hipparchus, we shall relate our theory of his real identity below.

Let us emphasize that the resulting 1800-year shift backwards concurs perfectly with one of the three primary chronological shifts that A. T. Fomenko has discovered in his analysis of the "Scaligerian history textbook". Fomenko has called this shift Graeco-Biblical, since it is manifest best in the "ancient" Greek and Biblical history, qv in CHRON1.

4. THE ERA OF NABONASSAR IN ACCORDANCE WITH THE LATE MEDIAEVAL SOLUTION

Our late mediaeval solution for the four planetary coverings of stars leads us to the following concept of the origin of the Almagest chronology. As we already pointed out, the main era used by Ptolemy is the era of Nabonassar. Apart from that, Ptolemy refers to the eras of Alexander and Dionysius, qv above. What eras would all of them be exactly? If the astronomical events reflected in the Almagest took place in the epoch of the XII-XVII century, what real eras could become reflected in the Almagest? In other words, what is the real identity of the Ptolemaic Nabonassar, Alexander and Dionysius?

Let us put forth the following hypothesis. The era of Nabonassar is most likely to stand for the era of the "Divine King", *nabonas* standing for "divine", or "celestial" (*nebyesniy* in Russian), and *sar* for "czar". Alternatively, Nabon-Assar might be a reference to Assyria, since "Assar" and "Assyria" are virtually the same word. Who would this "divine king" be, then? Possibly, Jesus Christ, which explains why this era is the primary one used by Ptolemy. This era was simply the Christian era, which was the basic chronological scale in the late Middle Ages – the Anno Domini era, in other words.

According to our reconstruction, Jesus Christ had lived in the XII century A.D. and, after a 100-year chronological shift backwards, became reflected in mediaeval history under the name of "Pope Gregory VII Hildebrand" (this important parallelism is discussed in greater depth in "Methods"). As we expound it in "The Foundations of History", the initial "A.D." mark was set at 1053 or 1054, instead of the authentic date – 1152 A.D. This is the year of the supernova explosion – stellar debris are known to us today as the famed Crab Nebula. This very star was described in the Gospels as the Star of Bethlehem. See more on the dating of this explosion in our book entitled "King of the Slavs". Mediaeval chronologists were 100 years off the mark, having shifted the date of the explosion to circa 1053 A.D. from its correct XII century location.

This is the very reason why certain old chronicles have preserved the information about Hildebrand (translated as "Ablaze with Gold") being born in 1020 A.D. ([64], page 216). Therefore, the Nativity date could be chosen as 1020 A.D., with a discrepancy of roughly 100 years. The final formulation of this idea is as follows. The Nabonassar Era, or the era of the "Celestial King", is none other but the A.D. era, erroneously counted off 1020 A.D. instead of 1152 A.D.

Let us now check whether this concept corresponds with the datings of the planetary coverings given by Ptolemy in the Nabonassar era chronology. It turns out that it does, and ideally so. Indeed, let us see what happens when we superimpose the beginning of the Nabonassar era over 1020 A.D., qv in fig. 10.10.

Ptolemy claims that the coverings of stars by planets as discussed above took place in the following years:

the 476th year of Nabonassar for Venus,
the 476th year of Nabonassar for Mars,
the 508th year of Nabonassar for Jupiter,
and the 519th year of Nabonassar for Saturn.

If we add 1020 years to each of these figures, we shall come up with the following datings:

1496 A.D. for Venus,
1496 A.D. For Mars,
1528 A.D. for Jupiter,
and 1539 A.D. for Saturn.

The concurrence is ideal. The only discrepancy is a one-year difference for Mars: 1496 instead of 1497.

This provides us with perfectly independent proof of the theory formulated above, according to which the late mediaeval astronomical solution of the XV-XVI century for the planetary coverings is a veracious one.

What could be said about the two other eras, then – the era of Dionysius and the era of Alexander (or "since the death of Alexander"), the ones that Ptolemy occasionally refers to? The picture isn't quite as clear here, but there is a self-implied possible explanation. In CHRON1 we discovered a 100-year chronological shift that moved certain late mediaeval events backwards in time. Moreover, in CHRON1, Chapter 6:13.9, CHRON6, Chapter 4 and CHRON6, Chapter 5 we demonstrate that the "ancient Dionysius" is but a reflection of the famous mediaeval chronologist Dionysius Petavius (1583-1652), whereas the "ancient" Alexander the Great is a phantom reflection of the famous sultan Suleiman I the Magnificent (1520-1566) to a large extent.

Apparently, the centenarian chronological shift made Dionysius Petavius "travel backwards in time", which gave birth to the XV-XVI century "Dionysius", a phantom double of his who had presumably lived in 1483-1522 A.D. Similarly, Suleiman the Magnificent became reflected as the phantom "Alexander the Great", whose lifetime was ascribed to the years 1420-1466.

Let us see what happens if we are to count the Ptolemaic datings given for Mars and Jupiter coverings from these "phantom dates" in the eras of Dionysius and Alexander. We come up with a perfect concurrence. See for yourselves. Since the "era of Dionysius" is counted from 1483, the Jupiter covering that took place in 1528 took place *exactly in the 45th year of Dionysius,* just like it had been reported by Ptolemy (1528–1483=45). See table 10.1 above. The Mars covering that dates to 1497 took place in the 14th year of Dionysius (1497-1483-14), while Ptolemy cites the 13th year of Dionysius. The discrepancy equals a single year.

The situation with the era of Alexander is somewhat more ambiguous. A correspondence with the Ptolemaic datings (the 83rd year of Alexander for Jupiter and the 52nd year of Alexander for Mars) shall be achieved if we are to count the era of Alexander from 1445, which falls on the middle of Suleiman's reign shifted backwards by a hundred years. If we are to count the dates from the "death of Alexander", the intervals shall be some 20 years smaller.

The final hypothetical picture of the Almagest chronology based on the late mediaeval solution is as follows.

The final editions of the Almagest date to the early XVII century – the epoch of Scaliger, Petavius and Kepler. The four planetary coverings in question were observed by astronomers in the XV-XVI century, or circa 100 years before the lifetimes of the late mediaeval characters in question. These coverings were initially dated correctly; their era in the Almagest is the era of Anno Domini = Nabonassar = The Divine King. The Nativity date was erroneously chosen as 1020 (instead of 1152 A.D., which is the authentic dating), being one of the two possible versions. Let us remind the reader that the second erroneous version adhered to by certain mediaeval chronologists dates this event to 1053 or 1054 A.D. – 33 years further into the future). Once again, let us reiterate that the correct date is 1152 A.D.

Mediaeval chronologists presided over by Scaliger, Petavius and, possibly, Kepler, began to create the erroneous "extended chronology". The first step had been the backdating of many XV-XVII century events by a hundred years, which gave birth to the phantom "ancient characters" such as "Dionysius" and "Alexander", who were the reflection of the real chronologist Dionysius Petavius and the real sultan Suleiman I the Magnificent. The datings of the planetary coverings were re-calculated for these two eras, which gave the very numbers that were written into the Almagest

as the datings of the coverings given in the eras of Dionysius and Alexander.

The process of creating the false chronology by no means ended there. In the next stage, real events of the XV-XVI century were shifted by the XVII century chronologist backwards by circa 1800 years, which resulted in the existence of such "ancient characters" as the phantom Nabonassar, Alexander, Dionysius etc.

5. THE DATING OF THE ALMAGEST'S CREATION AND HOW THIS BOOK ASSUMED ITS PRESENT FORM. PTOLEMY AND COPERNICUS

Ptolemy is presumed to have written the voluminous ***Geogrpaphy*** as well as the gigantic volume of the Almagest, which is the encyclopedia of mediaeval astronomy and applied mathematics that European and Asian scientists had presumably used for some fifteen hundred years.

"The last famous name we encounter in Greek astronomy is that of Claudius Ptolemy. We know nothing about his life except for the fact that he had lived in Alexandria starting with 120 A.D. His fame is based on the large astronomical tractate entitled the Almagest for the most part – the primary source for our knowledge of the Greek astronomy, which can undoubtedly be called the astronomical encyclopedia of the Middle Ages. Ptolemy is also the alleged author of several lesser tractates on astronomy and astrology … Apart from that, he is the author of an important work on geography and, possibly, another tractate on optics" ([65], pages 64-65).

As we already pointed out, one of the primary sections of the Almagest is the famous star catalogue contained in books 7 and 8. There are 13 books in the Almagest altogether. The catalogue contains descriptions of about a thousand stars complete with their coordinates (latitude and longitude) in the ecliptic coordinate system. Historians are of the opinion that the catalogue was compiled in the II century A.D. from the results of observations carried out by Ptolemy around 140 A.D., or, presumably, more than fifteen hundred years ago. However, starting with the XVIII century the astronomers who study the Almagest have been running into numerous oddities resulting from this Scaligerian dating. It was estimated that stellar coordinates in their Almagest rendition could not have been measured in that epoch, which led to extensive research of the Almagest star catalogue and numerous hypotheses concerning it. The history of this problem is related by the authors above in great detail.

We already mentioned that the results of a great body of research conducted rather recently by the American astrophysicist and astronomer Robert Newton with the aid of precise modern theories and computers came out in 1978 ([614]). The name of his book is eloquent enough – it is called ***The Crime of Claudius Ptolemy***. Robert Newton came to the conclusion that nearly all of the alleged "observations" collected in the Almagest are false. It turns out that the Almagest astronomical data either fail to correspond to the astronomical situation for the II century A.D. altogether, or represent exercises in theoretical calculation. That is to say that in many cases Robert Newton proved them to be results of mediaeval theoretical calculation as opposed to actual astronomical observations. In other words, the author of the Almagest simply wrote the results of his theoretical calculations into the Almagest claiming them to be observation results.

When we conducted an independent study of the issue, we were forced to develop a special method of dating old star catalogues based on the concept of dating the catalogue by the shift values of several stars as observed upon the background of their "immobile" neighbours. Although these shifts are rather small, it turns out that they alter the configuration of bright stars upon the celestial sphere rather visibly. Precise modern measurements of these shifts gave us the proof that the Almagest star catalogue is based on the observations of the VII-XIII century A.D. epoch, and not the II century A.D. (see above). More specifically, the "Ptolemaic" observations of bright stars which were deemed the most important in mediaeval astronomy were carried out in that epoch. It is very likely that the Almagest catalogue was expanded with the inclusion of dimmer and less famous stars in a later period, up until the XVI century. Let us emphasize that it is based on real astronomical observations erroneously dated to the II century A.D. by later chronologists. These observations really date to a much later epoch.

The Almagest was extremely important for the creation of the Scaligerian chronology – this is why Ptolemy is also credited with the authorship of such

works on chronology as the chronological "Canon" of kings referred to by Sir Isaac Newton in his tractate on chronology, for instance ([1298], page 294).

Let us formulate our reconstruction, basing it on everything we managed to learn about the epoch of the XVI-XVII century.

1) Ptolemy's Almagest is an encyclopaedia that contains the results of real astronomical observations carried out over the period of several hundred years. The earliest such observations date to the epoch of the X century A.D. the earliest. The Almagest observations may well date to the period up until the XVI century A.D. It had been a famous astronomical encyclopaedia of the Middle Ages which reflected the state of the epoch's astronomical science; the book would be changed, expanded and re-worked over the years. It may really have been printed in the XVI century.

2) However, even if printed XVI century editions of the Almagest did exist, they haven't reached our day. Ptolemy's Almagest, being a work of paramount chronological importance, was re-written to a large extent in the XVII century when the Scaligerian chronology of the "antiquity" was being introduced as part of the history falsification programme – this concerns the XV-XVI century history primarily. Its subsequent publication contained erroneous XVI century datings and numerous fabricated "ancient observations" which had really been the results of calculations based on the mediaeval astronomical theory of the XVII century. The theory related in the Almagest in its XVII century version is the very theory that served as one of the main foundations of the Scaligerian chronology.

The coordinates of planets, positions of the sun and the moon etc would be calculated backwards to fit the Scaligerian datings. The calculated astronomical configurations would then be declared the results of observations and written into the Almagest as carried out by certain astronomers in certain (Scaligerian) years. However, since the astronomical theory of the XVII century was a great deal less precise than today, calculations employing the modern formulae sometimes allow us to expose the fraud, as Robert Newton had done ([614]).

This is our reconstruction in a nutshell.

However, one cannot help asking about the theory of Copernicus, or the heliocentric theory, and its correspondence with all of the above. Ptolemy's theory turns out to have appeared around the same time as the theory of Copernicus. However, we were taught to think that there is an enormous temporal gap to separate the theories of Ptolemy and Copernicus and that they correspond to completely different levels of scientific knowledge, which makes their contemporaneity impossible. Ptolemy is presumed to have been bound by the superstition that a truly harmonious cosmology requires its centre to be the Earth, whereas Copernicus was free from such doctrines and bravely made the Sun the centre of the Universe.

However, this isn't quite so. It turns out that locating the centre of the Universe upon the Earth wasn't the only mediaeval doctrine. Another such doctrine was concerned with the ideal nature of the circle and the theory that a celestial body must necessarily move along an ideal circumference, which was backed up by the Ptolemaic scheme which claims planet to have complex trajectories representing the sum of several rotational movements. Copernicus was basing his theory upon this very doctrine of the ideal nature of circular movement. According to Robert Newton, "Copernicus in his rejection of the equant needed a model to replace it which would satisfy to the pure doctrine of even circular movement … The scheme of Copernicus is more complex than the equant … he did not regard the sun as the focal point of his theory – he uses the centre of the telluric orbit as such … in total, Copernicus uses four different models to represent six planets. Ptolemy needed just three different models for this purpose. It is therefore untrue that Copernicus had created a theory which was a lot more primitive than Ptolemy's … on the contrary, his theory was a great deal more complex than Ptolemy's despite the fact that he could have come up with a much simpler theory had he been quite as vehement a follower of the idea that the heliocentric theory is based upon as he had been insofar as the concept of even circular rotation was concerned" ([614], page 328).

Robert Newton proceeds to point out that the real "heliocentric concept only became widely accepted a hundred years later than the works of Copernicus came out" ([614], page 328). The XVII century, in other words. "Kepler was the first to have accepted the real heliocentric concept" ([614], page 328). This fact is important enough since it leads us to the follow-

ing question: what epoch does the edition of the Copernican work that reached our day really date to? Could it have undergone heavy editing a century later, in Kepler's epoch, or the first half of the XVII century?

We thus see that the theories of Ptolemy and Copernicus can really be ascribed to the same knowledge level of celestial mechanics, and could therefore have appeared simultaneously. Both of them are based on obsolete mediaeval doctrines which were detrimental to the construction of a correct cosmology, the sole difference between them being in the doctrines that they're based upon.

Ptolemy's theory was more advanced calculation-wise. It must have been acknowledged as more correct in the XVI-XVII century and "set down as numbers". The parallel theory of Copernicus enjoyed a great deal less attention – although, as we can see nowadays, it is closer to the truth in principle than Ptolemy's theory, its more approximated results notwithstanding. It was only in the XVII century that the correct heliocentric theory was formulated, and it hadn't received recognition until the publication of Kepler's works.

We come up with an important corollary in this respect. Ptolemy's Almagest in its present shape was created in the seventeenth century, and made to look "ancient" by its creators in order to serve as the foundation of the Scaligerian chronology which was being created in this exact epoch. Therefore, the astronomical events which could be calculated backwards with the aid of the XVII century theory are dated according to Scaligerian chronology in the Almagest, with as much precision as the imperfect astronomical theory of the XVII century would allow. It would therefore be expedient to treat the Almagest data with the utmost caution if we are to use them for the purposes of chronology, or the reconstruction of the old dates. One has to constantly bear in mind that these data were processed by the XVII century chronologists in order to validate the nascent Scaligerian chronology with the help of "ancient documents". Thus, the only data we can safely use are those which could not have been calculated in the XVII century, such as the solar eclipses, the exact phases of lunar eclipses and the celestial positions of stars. However, the XVII century falsifiers naturally tried to make sure no such data would survive insofar as it were possible at all.

A vivid example is the "mysterious" lack of a single reference to solar eclipses anywhere in the Almagest. Could the ancient astronomers have failed to pay attention to the most spectacular astronomical event of them all? This oddity of the Almagest was pointed out by N. A. Morozov, who wrote the following: "I would like to turn the reader's attention to a very strange characteristic of the Almagest. Why would the author describe so many ancient lunar eclipses (and erroneously for the most part, at that) as well as lunar coverings of several stars, did not mention a single solar eclipse, although such eclipses are a great deal more spectacular? This is perfectly clear from my point of view. Lunar eclipses as well as coverings of stars by the moon are a great deal easier to calculate than the solar eclipses since the former can be observed from the surface of the entire hemisphere where the moon is visible, whereas the solar eclipses can only be seen from the strip of telluric surface which was covered by the eclipse … In this very epoch [the Scaligerian epoch of Ptolemy – Auth.] many rather spectacular solar eclipses were observable from Alexandria [where Ptolemy is supposed to have worked – Auth.]. How could he have failed to mark out the annular solar eclipse of the 21st April 125? … Nevertheless, we see that "his book" contains a detailed description of the lunar eclipse that took place two weeks before it, on the 5th April 125. This fact alone, apart from the lack of any references to the spectacular partial solar eclipses that could be observed from Alexandria on 2nd July 121 and the 3rd September 118, would suffice in order to state with the utmost certainty that someone who failed to observe and point out a solar eclipse like this one hadn't observed the lunar eclipse preceding it, either, since such an observer would pay attention to the solar eclipse first and foremost … Yet Ptolemy appears to have slept through every solar eclipse!" ([544], Volume 4, pages 472-473).

We have used the simple Turbo-Sky application which is very convenient for approximated calculations, as well as the famous solar eclipse canon compiled by Ginzel in the XIX century ([1154]) in order to run a check on the solar eclipses listed by N. A. Morozov. Indeed, all the eclipses in question took place on the dates specified, and they were indeed observable perfectly well from Egypt, including Alexandria. The path of the total eclipse of 125 A.D., for instance,

covered Arabia; the eclipse was partial as observed from Alexandria, yet perfectly visible. The solar eclipse of 118 A.D. was the most conspicuous as observed from Alexandria. Thus, a total of three conspicuous solar eclipses fall on the Scaligerian lifetime of Ptolemy; moreover, all of them could be observed from Alexandria where he is supposed to have work. This happens to be a very rare case indeed – yet Ptolemy "failed to have noticed" any of them. None of the above is a mystery to us, since there was no Ptolemy and no Alexandria in 125 A.D. – they cannot possibly predate the epoch of the IX-XI century A.D. The falsifiers of the XVII century who "dated" the Almagest to the second century A.D. could not calculate solar eclipses due to the drawbacks of the theory that they used. Tough luck.

N. A. Morozov also discovered many interesting facts in other works of the "ancient" Ptolemy. His conclusion is as follows: "It is perfectly impossible to allow for such a voluminous and detailed oeuvre which represented the state-of-the-art astronomical science until the very epoch of Copernicus (or 1543) to have been created in this very form more than a thousand years earlier remaining free from additions and corrections … the same is true for the eight volumes of the ***Geography*** ascribed to the same author, where the longitudes and latitudes of places upon the surface of the earth are given in degrees, and the first meridian is considered to be the one that passes through the Canary Islands! The same is true for his ***Optics*** which, among other things, was written in awareness of the modern reflection and refraction theory which remained unknown to the mediaeval Greeks and Italians until the Renaissance" ([544], Volume 4, pages 473-474).

6. THE "ANCIENT" HIPPARCHUS AS THE APPARENT PHANTOM REFLECTION OF TYCHO BRAHE, THE FAMOUS ASTRONOMER

Let us formulate the hypothesis that the prominent "ancient" astronomer Hipparchus is but a phantom reflection of the famous mediaeval astronomer Tycho Brahe who had lived in the XVI century A.D. In the beginning of the XVII century, when the "distant antiquity" was being filled up with the phantom duplicates of mediaeval events, and during the editing of the Almagest, the Scaligerite historians duplicated the astronomer Tycho Brahe, having moved one of the versions of his biography deep into the past, where it had created another mirage, namely, the "great ancient astronomer Hipparchus". Let us briefly study the parallelism between the existing data concerning Tycho Brahe and Hipparchus.

1a. Life dates of the "ancient" Hipparchus.
Scaligerites have placed the "ancient" Hipparchus approximately in 185-125 B.C. ([395], page 123). He is presumed to have been the first great astronomer of the "antiquity". I. A. Klimishin writes that "very little is known about the life of Hipparchus" ([395], page 43).

■ *1b. Life dates of Tycho Brahe.*
The great mediaeval astronomer Tycho Brahe is presumed to have lived in 1546-1601 A.D. ([395], page 123). A comparison of these dates with the Scaligerian dating of the lifetime of the "ancient" Hipparchus demonstrates the difference between them to equal circa 1730 years. This value is very close to that of approximately 1780 years, which is the shift we have discovered in our previous work. We called this shift Graeco-Biblical, since the Scaligerian chronologists would add 1780 years to the datings of the Greek and Biblical historical events. A propos, the actual biography of Tycho Brahe only reached us in an edited form, that is to say, it went through the hands of the XVII century censors, and was thus put in accordance with the Scaligerian version of history.

2a. The compilation of a star catalogue by the "ancient" Hipparchus.
Hipparchus is presumed to have compiled a "star catalogue that included 850 objects" ([395], page 51). Latitudes, longitudes and stellar magnitudes (or brightness) were indicated for every star. Hipparchus divided the stars into six classes, the first of which included the brightest stars, and the sixth – the dimmest. The star catalogue of Hipparchus is presumed to have been very well-known in the "antiquity"; however, it didn't reach our age. Nowadays it is presumed that "the

only surviving oeuvre of Hipparchus is his commentary to the poem of Aratus and its original source (the work of Eudoxus). All our knowledge of Hipparchus and his works comes from the Almagest where Ptolemy expresses his admiration for Hipparchus on every other page" ([395], page 52). Thus, the star catalogue of Hipparchus with the description of 850 stars is presumed to have not survived.

■ *2b. The compilation of a star catalogue by Tycho Brahe.*
Tycho Brahe had compiled a "star catalogue that comprised 788 stars" ([395], page 129). Longitudes, latitudes and magnitudes were stated for every star. However, his catalogue was apparently published a great deal later, in the Rudolphine Tables compiled by Kepler, a student of Tycho Brahe. The following is said about the catalogue of Tycho Brahe: "In 1627 the Rudolphine Tables came out, which were to be used for preliminary calculations of the sun, the moon and the planets for the next 100 years or so, serving as a handbook for the astronomers and seafarers. The book also contained a catalogue that included 1005 stars which was based on the 777-star catalogue compiled by Tycho Brahe" ([395], pages 148-149). Tycho Brahe is supposed to have made a large cosmosphere with "the Zodiacal belt, the equator and the positions of 1000 stars whose coordinates were calculated over the years of Tycho's observations . . . this had truly been a marvel of science and art; sadly, it was destroyed by a blaze in the second part of the XVII century" ([395], page 127).

3a. The "ancient" Hipparchus observed a supernova explosion.
Hipparchus is supposed to have begun his compilation of a star catalogue after having observed a supernova explosion ([395], page 51). This unique event "had led Hipparchus to the thought that the world of stars might be subject to certain changes" ([395], page 51). This is reported by the "ancient" Roman author Pliny the Elder in particular, whose lifetime is dated as 23-79 A.D. by the Scaligerites ([395], page 51). As we understand it nowadays, the "ancient" Pliny was really a contemporary of Tycho Brahe, and therefore he couldn't have lived earlier than the end of the XVI century A.D.

■ *3b. Tycho Brahe observed a supernova explosion.*
"On 11 November 1572 … Tycho Brahe noticed a bright star in the constellation of Cassiopeia, which hadn't been there before … Tycho's supernova (as this star is called nowadays) exceeded Venus in brightness. It could even be observed during the day for some time; it remained visible to the naked eye for 17 months. This event would naturally agitate a great many people. All sorts of theories and presumptions about this strange luminary and what it might portend were voiced" ([395], pages 124-125). Tycho Brahe wrote the following about this star: "I was so amazed by this sight that it did not shame me to question what my own eyes were telling me … could this have been the greatest wonder that ever took place since the Genesis?" Quotation given according to [395], page 124. Kepler said that "even if this star wasn't an omen of any sort, it heralded and created a great astronomer". Quoting by [395], page 124.
This supernova explosion of 1572 became reflected in the biography of Tycho Brahe = Hipparchus, which was shifted by 1730 years into the past by the historians.

4a. The "ancient" Hipparchus built an astronomical observatory on the island of Rhodes.
Hipparchus is presumed to have "worked on the isle of Rhodes, where he had built an astronomical observatory" ([395], page 43). We know of no details; however, our reconstruction shall demonstrate these details to be present in Tycho Brahe's biography.

■ *4b. Tycho Brahe built an astronomical observatory on the island of Hvenna.*
"In 1576 Tycho Brahe received the island of Hvenna as a gift from king Frederick II (20 kilometres to the south-east of Copenhagen) … Tycho Brahe built the observatory of Uraniborg on the island (translates as "the castle of Urania"). [Klimishin's commentary is as

follows: "bear in mind that Uraniawas the name given by the ancient Romans to the goddess of the skies"]. It was equipped with precise goniometrical instruments. Several years later, the observatory of Stjerneborg (or the "Stellar Castle") was erected nearby, where the measurement instruments were mounted underground in order to be protected from the wind. Thus, the isle of Hvenna became a world centre of astronomical science for twenty years. This is where observations of exceptional precision were conducted and qualified astronomers trained, the ones that later worked in other European cities … The expenses for the construction and maintenance of Tycho Brahe's observatory comprised a significant part of the state budget [of Denmark – Auth.] … The fame of the Uraniborg observatory and its creator had spread all across Europe, and aspiring apprentices and helpers were coming from Tycho from everywhere" ([395], pages 126-127). All of this is presumed to have been financed from the modest treasury of the Danish king. However, it is most likely that the observatory was financed by the Empire.

The observatory of Tycho Brahe did not survived. "A mere couple of decades later, visitors coming to the site of the magnificent astronomical observatory of Uraniborg could see nothing but a pit filled with rubbish there" ([395], page 128).

Commentary. How could the famous observatory have disappeared? We are being told that it had been "levelled", and this "trash-filled pit" marks its former site. However, it would be a great deal more convenient to build an observatory in the south, close to the equator. The isle of Rhodes, where the "ancient" authors report the observatory of Hipparchus (or Tycho Brahe) to have been located is a much more fitting location for astronomical observations. The proximity to the equator implies that a larger portion of the sky is visible due to the rotation of the earth as opposed to the near-polar latitudes. The climate of Denmark is also hardly beneficiary due to fogs etc.

Let us now turn to the inscription on the famous mediaeval portrait of Tycho Brahe ([1460:1], fig. 10.11).

Fig. 10.11. A mediaeval portrait of Tycho Brahe. Taken from [1460:1]. See also [98], page 209.

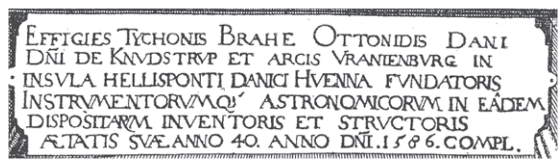


Fig. 10.12. A close-in of the inscription on the old portrait of Tycho Brahe. Taken from [1460:1]. See also [98], page 209.

It tells us the following (see the magnified inscription in fig. 10.12).

What we see here is the clear indication that Uranienborg was located on the isle of Hellespont (in insula Hellesponti). The location of the Hellespont is well known – it is the old name for the Dardanelles straits, whose western coast is the famous peninsula with a very narrow isthmus ([797], page 284). The "isle of Hellespont" could also refer to some island in the vicinity of the Dardanelles.

Where did the mention of Denmark in Tycho

Brahe's biography come from, then? The matter is that the word "Denmark" (or "Dani") often meant "the land on the Danube" in old texts. The Biblical "tribe of Daniel" is of a similar origin. This means the Balkans. The straits of Hellespont and the neighbouring peninsula are located close nearby. This small peninsula is a part of the larger Balkan peninsula, qv on the map. It becomes clear why the inscription on the portrait of Tychon the Varangian (or Tychonis Brahe / Tycho Brahe) mentions the "danio Hvenna", or the "Vienna near the Danube" – Venice, in other words. All these places are in the Mediterranean region, and the isle of Rhodes, where the "ancient" observatory of Hipparchus was located, lays to the south. Therefore, the observatory of Tychon the Varangian from the XVI century (alias Tycho Brahe or Hipparchus) was either located on the Rhodes or the Hellespont peninsula, closer to the capital – Czar-Grad = Istanbul. It was only in the XVII century that Tycho Brahe and his observatory were moved to the misty northern Denmark (on paper). However, his "ancient" duplicate (Hipparchus) remained on Rhodes.

As we can see, a lot of what we're telling the reader is written quite unequivocally in the ancient documents, even the ones that underwent the Scaligerian censorship. One just has to read them from a new point of view, which will make the vague and unclear documents of the old days clear and easily understandable.

5a. The name of Hipparchus. The famous "ancient" astronomer was called Hipparchus.

■ *5b. The name of Tycho Brahe.* The great mediaeval astronomer was called Tycho Brahe. The name of Hipparchus may well be a corrupted version of *TychoBrahe*, or *T-Hoprach* (*T-Hipparch*), due to the similarity between *h* and *ch* and the flexion of *b* and *p*. Having removed the first letter *T* from the name of Tycho Brahe, Scaligerites transformed him into Hipparchus. The fact that Ptolemy makes countless references to Hipparchus means that the edition of the Almagest that we have at our disposal today was created *after Tycho Brahe = Hipparchus*. Hence, it couldn't have taken place before the beginning of the XVII century (bearing in mind that Tycho Brahe died in 1601).

7. PTOLEMY'S ALMAGEST IS MOST LIKELY TO HAVE UNDERGONE ITS FINAL EDITION ALREADY AFTER THE DEATH OF TYCHO BRAHE, OR THE "ANCIENT" HIPPARCHUS

Thus, we have reasons to believe that the famous mediaeval astronomer Tycho Brahe (1546-1601) became reflected in the "Scaligerian antiquity" as the great "ancient" astronomer Hipparchus who is supposed to have lived around 180-125 or 190-125 B.C. ([797], page 307). According to our reconstruction, the final edition of Ptolemy's Almagest took place after the death of Tycho Brahe, in the epoch of Johannes Kepler (1571-1630).

Therefore, Ptolemy's Almagest as well as the star catalogue it contains, had been edited up until the beginning of the XVII century A.D. The 1771 edition of the Encyclopaedia Britannica ([1118]) which we already referred to above gives us an opportunity of supplementing this corollary with another independent fact which is well explained by our reconstruction and was pointed out to us by our readers.

The large section of the 1771 Britannica entitled "Astronomy" contains a noteworthy comparative table with quantities of stars observed by various astronomers of the "antiquity" and the Middle Ages and included into their star catalogues ([1118], Volume 1, pages 486-487). Namely, we see the data pertaining to the catalogues of Claudius Ptolemy (who had allegedly lived around 90-160 A.D.), Tycho Brahe (1546-1601), Johannes Hevelius (1611-1687) and John Flamsteed (1646-1719). This comparative table can be seen in figs. 10.13 and 10.14.

The first column contains the constellation of the Northern and the Southern Hemisphere together with their Latin names.

The second column contains the English translations of the Latin constellation names.

The third column tells us how many stars in each of the abovementioned constellations were mentioned by Claudius Ptolemy.

The fourth column contains the stars mentioned by Tycho Brahe.

The fifth column contains the stars mentioned by Johannes Hevelius.

The ancient Conſtellations.		*Ptolemy.*	*Tycho.*	*Hevelius.*	*Flamſteed.*
Urſa minor	The Little Bear	8	7	12	24
Urſa major	The Great Bear	35	29	73	87
Draco	The Dragon	31	32	40	80
Cepheus	Cepheus	13	4	51	35
Bootes, *Arctophilax*		23	18	52	54
Corona Borealis	The Northern Crown	8	8	8	21
Hercules, *Engonaſin*	Hercules kneeling	29	28	45	113
Lyra	The Harp	10	11	17	21
Cygnus, *Gallina*	The Swan	19	18	47	81
Caſſiopea	The Lady in her Chair	13	26	37	55
Perſeus	Perſeus	29	29	46	59
Auriga	The Waggoner	14	9	40	66
Serpentarius, *Ophiuchus*	Serpentarius	29	15	40	74

Serpens

Fig. 10.13. A comparative table of the stars that entered the catalogues compiled by the four famous astronomers: Ptolemy, Tycho Brahe, Johannes Hevelius and John Flamsteed. The table is taken from the 1771 edition of the ***Encyclopaedia Britannica***, the Astronomy section. In the first column of the table we see the names of the constellations from the Northern and then the Southern Hemisphere of the celestial sphere, together with their names in Latin. The second column contains the English translations of the Latin names. In the third column we find the amount of stars in listed constellations indicated by Ptolemy, in the fourth – the ones indicated by Tycho Brahe, with respective data for Hevelius and Flamsteed in the fifth and the sixth columns. Taken from [1118], Volume 1, pages 486-487.

Finally, the sixth column is reserved by John Flamsteed.

The order of the astronomers is naturally given in accordance with the Scaligerian chronology. The "ancient" Ptolemy is mentioned first, followed by the mediaeval astronomers Brahe, Hevelius and Flamsteed.

The cited table demonstrates the following rather interesting effect (see figs. 10.13 and 10.14). The last three star catalogues (by Tycho Brahe, Johannes Hevelius and John Flamsteed) follow each other in a natural order – chronologically as well as content-wise. This is to say that each of the subsequent catalogues is more complete than the one that precedes it, which is perfectly natural – astronomical instruments were perfected over the course of time, providing for new opportunities. Each of the mediaeval astronomers would try to expand the catalogue of his predecessor, adding new stars thereto.

However, the catalogue of the "ancient" Claudius Ptolemy fails to fit into this natural picture. It turns out to be a great deal more detailed than the catalogue of Tycho Brahe, which can be easily seen from the corresponding table columns. The "ancient" Ptolemy had observed many more stars in almost every constellation than the mediaeval Tycho Brahe. The implication is that the mediaeval Tycho Brahe had "forgotten" the great achievements of the "ancient" astronomy. Specialists in history of astronomy are trying to convince us that the "ancient" Ptolemy could observe a lot more stars than Tycho Brahe who had lived 1.300 years later ([1118], Volume 1, pages 486-487).

Our reconstruction provides a perfect explanation for this oddity, which is a result of the erroneous Scaligerian chronology. The matter is that Ptolemy's catalogue, or, rather, the edition that has reached our day, is simply misplaced chronologically. It contains more stars than Brahe's catalogue, but less of them as compared to the catalogue of Hevelius. What we have to do is make the respective catalogues of Ptolemy and Tycho Brahe swap places; the correct star catalogue should therefore be as follows:

1) The first catalogue should be the rather compact one compiled by Tycho Brahe, which must be the oldest star catalogue to have reached our age.

2) It is to be followed by the more detailed catalogue of Claudius Ptolemy, or, rather, the version that we have at our disposal today.

3) The next catalogue is the one compiled by Johannes Hevelius with even more content.

4) The last catalogue is John Flamsteed's, the most extensive of them all.

This order eliminates all oddities instantly. The Tychonian catalogue turns out to be the oldest of the four and therefore contains less stars than the other

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The ancient Conſtellations.		*Ptolemy.*	*Tycho.*	*Hevelius.*	*Flamſteed.*
Serpens	The Serpent	18	13	22	64
Sagitta	The Arrow	5	5	5	18
Aquila, *Vultur*	The Eagle	15	12	23	71
Antinous	Antinous		3	19	
Delphinus	The Dolphin	10	10	14	18
Equulus, *Equi ſectio*	The Horſe's Head	4	4	6	10
Pegaſus, *Equus*	The Flying Horſe	20	19	38	89
Andromeda	Andromeda	23	23	47	66
Triangulum	The Triangle	4	4	12	16
Aries	The Ram	18	21	27	66
Taurus	The Bull	44	43	51	141
Gemini	The Twins	25	25	38	85
Cancer	The Crab	23	15	29	83
Leo	The Lion	35	30	49	95
Coma Berenices	Berenice's Hair		14	21	43
Virgo	The Virgin	32	33	50	110
Libra, *Chelæ*	The Scales	17	10	20	51
Scorpius	The Scorpion	24	10	20	44
Sagittarius	The Archer	31	14	22	69
Capricornus	The Goat	28	28	29	51
Aquarius	The Water-bearer	45	41	47	108
Piſces	The Fiſhes	38	36	39	113
Cetus	The Whale	22	21	45	97
Orion	Orion	38	42	62	78
Eridanus, *Fluvius*	Eridanus, *the River*	34	10	27	84
Lepus	The Hare	12	13	16	19
Canis major	The Great Dog	29	13	21	31
Canis minor	The Little Dog	2	2	13	14
Argo Navis	The Ship	45	3	4	64
Hydra	The Hydra	27	19	31	60
Crater	The Cup	7	3	10	31
Corvus	The Crow	7	4		9
Centaurus	The Centaur	37			35
Lupus	The Wolf	19			24
Ara	The Altar	7			9
Corona Auſtralis	The Southern Crown	13			12
Piſcis Auſtralis	The Southern Fiſh	18			24

The new Southern Conſtellations.

Columba Noachi	Noah's Dove	10
Robur Carolinum	The Royal Oak	12
Grus	The Crane	13
Phœnix	The Phenix	13
Indus	The Indian	12
Pavo	The Peacock	14
Apus, *Avis Indica*	The Bird of Paradiſe	11
Apis, *Muſca*	The Bee or Fly	4
Chamæleon	The Chameleon	10
Triangulum Auſtralis	The South Triangle	5
Piſcis volans, *Paſſer*	The Flying Fiſh	8
Dorado, *Xiphias*	The Sword Fiſh	6
Toucan	The American Gooſe	9
Hydrus	The Water Snake	10

Hevelius's Conſtellations made out of the unformed Stars.

		Hevel.	*Flamſt.*
Lynx	The Lynx	19	44
Leo minor	The Little Lion		53

		Hevel.	*Flamſt.*
Aſterion & Chara	The Greyhounds	23	25
Cerberus	Cerberus	4	
Vulpecula & Anſer	The Fox and Gooſe	27	35
Scutum Sobieſki	Sobieſki's Shield	7	
Lacerta	The Lizard	10	16
Camelopardalus	The Camelopard	32	58
Monocerns	The Unicorn	19	31
Sextans	The Sextant	11	41

There is a remarkable track round the heavens, called the *Milky Way*, from its peculiar whiteneſs, which was formerly thought to be owing to a vaſt number of very ſmall ſtars therein: but the teleſcope ſhews it to be quite otherwiſe; and therefore its whiteneſs muſt be owing to ſome other cauſe. This track appears ſingle in ſome parts, in others double.

There are ſeveral little whitiſh ſpots in the heavens, which appear magnified, and more luminous when ſeen through teleſcopes; yet without any ſtars in them. One of theſe is in Andromeda's girdle, and was firſt obſerved *A. D.* 1612, by Simon Marius: it has ſome whitiſh rays

Fig. 10.14. The table continued. Taken from [1118], Volume 1, pages 486-487.

three. Then either Ptolemy or the XVII century editors of his catalogue expanded the number of stars observed. It was only after that than the more complete catalogues of Hevelius and Flamsteed were compiled.

This is the corollary we can make after the analysis of the information that had been at the disposal of the authors of the 1771 Britannica. It would be most interesting to study the evolution of different Almagest editions preceding and following 1771. Could the data contained in the presumably "ancient" Almagest have been "corrected" in retrospect, already after 1771?

As we demonstrated above, Ptolemy's star catalogue had been compiled in the epoch of the VII-XIII century A.D., and cannot possibly date to the II century A.D. as the Scaligerites tell us. However, we can see that the Almagest had been edited and expanded up until the early XVII century. In particular, it was supplemented by new stars observed in the post-Tychonian epoch.

8. ACCORDING TO ROBERT NEWTON, MOST OF THE LUNAR ECLIPSES REFERRED TO IN THE ALMAGEST HAPPEN TO BE RELATIVELY RECENT FORGERIES

Let us discuss the issue of whether the Almagest can be dated by the Ptolemaic descriptions of lunar eclipses. The Almagest mentions 21 of those, telling us that they were observed by different astronomers over a period of 850 years – from the 26th year of Nabonassar to the 881st. The following characteristics are cited by Ptolemy in his description of the eclipses:

1. The year of the eclipse given according to one era or another – the way it was given in the source allegedly quoted by Ptolemy. These dates are converted into the era of Nabonassar in most cases.

2. The phase of the eclipse according to the source that Ptolemy is presumed to quote from.

3. The date of the eclipse and the moment of the eclipse's central stage. These data were calculated by Ptolemy himself and are of no use for the purposes of dating.

4. The location of the eclipse. Since the eclipse was observable from an entire hemisphere, this information is also of marginal importance to us.

Ptolemy fails to indicate the phase of three eclipses out of twenty-one. An eclipse with some phase can be observed every year, from every point upon the surface of the earth – or even several eclipses. Therefore the mention of an eclipse that took place in one year or another is of no use to us when no phase is specified, since we can find such an eclipse in any year. Thus, only 18 eclipses from the Almagest list can be of interest for the purposes of dating.

A serious analysis of the Almagest lunar eclipses was conducted by Robert Newton in [614]. He had discovered many indications testifying to the fact that most of these eclipses are in fact forgeries. Curious readers can study Robert Newton's book entitled ***The Crime of Claudius Ptolemy*** ([614]). We shall merely cite the table that contains the results of his research herein. Robert Newton claims the following to be true:

"The triad of lunar eclipses (–720), 19 March, (–719), 8 March and (–719), 1 September. One of the them is definitely a forgery, the others are likely to be forgeries as well.

The triad of lunar eclipses (–382), 23 December, (–381), 18 June and (–381), 12 December. Forgeries.

The triad of lunar eclipses (–200), 22 September, (–199), 19 March and (–199), 12 September. Forgeries.

The lunar eclipse of the 25 April (–490) might be authentic [or, as we are beginning to understand nowadays, it had better chances of being reversely calculated in the XVII century – Auth.]

The lunar eclipse of the 5 April 125 might be authentic [or, as we are beginning to understand nowadays, it had better chances of being reversely calculated in the XVII century – Auth.]

The lunar eclipse of the 19 November (–501) might be authentic [or, as we are beginning to understand nowadays, it had better chances of being reversely calculated in the XVII century – Auth.]

The lunar eclipse of the 22 April (–620) is a forgery.

The lunar eclipse of the 16 June (–522) is a forgery.

The lunar eclipse of the 1 May (–173) is a forgery.

The lunar eclipse of the 27 January (–140) is a forgery." ([614], page 334).

R. Newton proceeds to tell us that "Ptolemy does the same for the eclipse triad that he claims to have observed in the years of 133, 134 and 136 … This re-

search is based on a forgery. All the eclipses that he claims to have observed are forgeries, as well as the middle eclipse in the ancient triad. We can make no final corollary concerning the authenticity of the two other eclipses from the ancient triad, but are inclined to believe that they are forgeries as well" ([614], page 147).

Thus, Robert Newton had discovered that most of the lunar eclipses mentioned in the Almagest are forgeries, which means they were calculated theoretically in some later epoch and then included into the Almagest as authentic "ancient observations". As for the few eclipses that Robert Newton made no final conclusion about are most likely to have been calculated by the XVI-XVII century astronomers with more accuracy, as we are beginning to understand nowadays.

Hence we cannot consider the lunar eclipse list from the Almagest to be reliable material fit for the purpose of independent astronomical dating. This false "ancient list" was most probably forged by the Scaligerian astronomers and chronologists in the XVI-XVII century in order to validate the claim that the Almagest is an "ancient" tractate.

Nevertheless, we have conducted the necessary lunar eclipse calculations in order to determine whether the respective Almagest data contradict our mediaeval dating of the book. As a result we managed to find satisfactory mediaeval solutions for almost all of the 18 lunar eclipses that Ptolemy describes in detail, with the indication of the phase. The lunar eclipse solution that we found dates the beginning of the Nabonassar era to approximately 465 A.D., spanning the epoch of 491-1350 A.D. dating-wise. Bear in mind that there are 21 eclipses mentioned in the Almagest altogether.

However, all of the facts mentioned above cannot allow us to present the lunar eclipse calculations as independent proof of our chronological result. One could just as easily find an ancient solution insofar as the eclipses are concerned. All we are claiming is that the Ptolemaic eclipse data do not contradict our dating of the Almagest star catalogue, even if some of them are really XVII century forgeries.

CHAPTER 11

Other problems and hypotheses arising from the dating of the Almagest catalogue

A. T. Fomenko, G. V. Nosovskiy

1. CERTAIN AUXILIARY ODDITIES OF THE ALMAGEST

1.1. What coordinates was the Almagest catalogue compiled in initially?

As we already know, one of the Almagest's most important parts is the catalogue of stars that contains around 1000 entries, with the indication of their ecliptic latitudes and longitudes. N. A. Morozov (in [544], Volume 4) voiced the opinion that the Almagest catalogue was initially compiled in natural equatorial coordinates, just like the modern catalogue, and was only converted into a catalogue with ecliptic coordinates as a result of some calculations. The matter is that the mediaeval astronomers considered the ecliptic coordinates "eternal", believing their latitudes to remain constant and the precession-driven growth of coordinates to happen at an unchanging rate. When it was discovered that ecliptic coordinates also change over the course of time, their "benefit" ceased to exist.

Vestiges of the conversion of equatorial coordinates into their ecliptic equivalents as mentioned above can be found with several methods. The compiler of the Almagest catalogue describes the stars of the Northern Hemisphere first, beginning with the northernmost constellations and slowly proceeding southwards. It would therefore be natural to assume that he should start his catalogue with the description of the constellation located at the centre of the hemisphere, namely, the ecliptic pole. Which constellation of the Northern Hemisphere is the closest to the ecliptic pole? It is the constellation of Draco. The position of the ecliptic pole has only changed marginally over the last 2000 years (as a result of the ecliptic's fluctuations) in comparison to the sizes of the constellations. Therefore, the compiler of the catalogue, whatever his chronological location on the time axis between today and the epoch of the "ancient" Greece, would have to start his catalogue with the constellation of Draco. Oddly enough, this isn't the case with the Almagest, whose catalogue begins with Ursa Minor and not Draco, for some strange reason ([704], page 224). The compiler proceeds to describe the stars of Ursa Major, and only then lists those of Draco, naming the latter constellation third, no less! See fig. 2.1 in Chapter 2, which depicts all 48 constellations described in the Almagest. In fig. 2.13 of Chapter 2 we see the order of the constellation as listed in the Almagest. This order is rather odd.

Everything shall fall into place once we come back to the equatorial coordinate system. The matter is

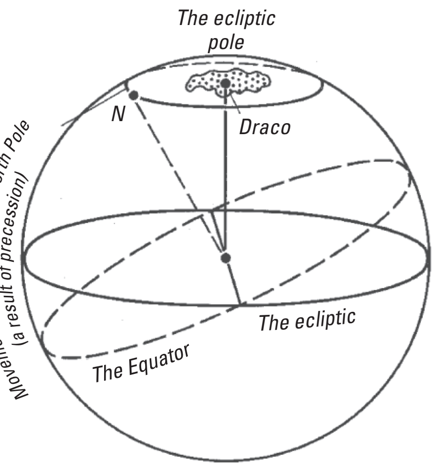


Fig. 11.1. The motion of the North Pole around the ecliptic pole as a result of precession. The constellation of Draco is located at the North Pole of the ecliptic coordinate system.

that there was indeed a period of the historical time interval when Ursa Minor was the closest constellation to the pole, or the centre of the equatorial coordinate system. Thus, the compiler of the catalogue de facto shows us the initial version of the latter by beginning the list with the stars of Ursa Minor – therefore, the Almagest catalogue began with the pole of the Equatorial coordinate system (see fig. 11.1).

N. A. Morozov wrote the following in this respect: "However, in this case, why didn't he leave the actual equatorial values alone, the way it is done in all the modern star catalogues, and had to convert them into ecliptic latitudes and longitudes with the laborious graphical method? … The result was the inevitable secondary error that compromised the value of the catalogue in general … The tremendous amount of the author's labour required for converting the "immobile stars'" coordinates into ecliptic coordinates from the initial equatorial values … makes such exorbitant waste and happens to be so obviously detrimental to astronomical precision that one involuntarily begins to search for some ulterior motive behind all this, with only two possibilities – either a vain desire to make the catalogue eternal (a non-option due to longitudes, as it turns out), or a deliberate effort of hiding the time when the catalogue was compiled, seeing as how ecliptic latitudes were considered immutable before Newton and Laplace …" ([544], Volume 4, page 201).

This brings us to another obvious question. Since the North Pole's position among the constellation alters visibly with the course of time, is it possible to use this information for the dating of the Almagest catalogue, with the knowledge of the laws that this alteration conforms to?

1.2. The North Star as the first star of the Almagest catalogue

The Almagest catalogue begins with the North Star. This seems to be perfectly natural at first – indeed, given that the catalogue lists the stars of the Northern Hemisphere, it is only natural that the compiler should begin his list of stars in equatorial coordinates from the star closest to the centre of the Northern Hemisphere, or the pole. However, if we are to consider this issue with more attention, we shall come up with a whole range of perplexed questions.

Modern Scaligerian chronology tries to convince us that the Almagest was compiled around II century A.D., or somewhat earlier, under Hipparchus (in the alleged II century B.C., that is). It is easy enough to calculate that the constellation of Ursa Minor remains closest to the North Pole out of all the constellations listed by Ptolemy, and there were no significant alterations in its disposition over the length of the historical interval, or the period of the last 2.500 years. Further on, it is also easy to calculate which of Ursa Minor's stars was the closest to the pole around the beginning of the new era, which is when the Almagest is presumed to have been compiled. This star turns out to be the Beta of Ursa Minor. Moreover, it is marked as a star of the second magnitude order in the Almagest, which makes it brighter than the North Star, marked as the star of the third magnitude order in the Almagest and therefore dimmer than Beta.

Incidentally, it has to be noted that one can find no modern star names in the Almagest (such as Alpha, Beta etc). Ptolemy localises the stars by their disposition towards the constellation figure and by their coordinates. Let us point out that in reality the magnitudes of Ursa Minor's Alpha and Beta are virtually identical – namely, according to the modern photometric data, the magnitude of Alpha equals 2.1, and

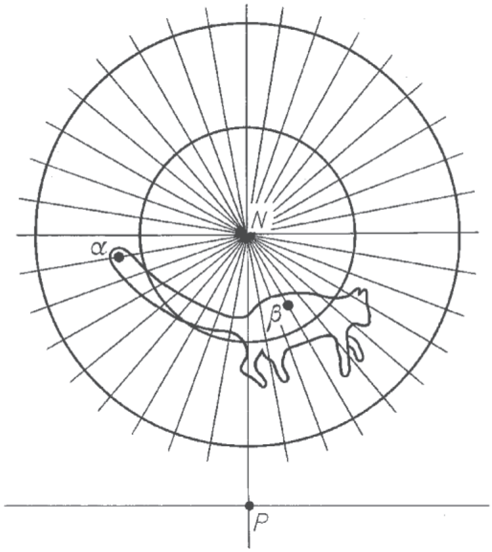


Fig. 11.2. The disposition of Alpha and Beta stars in the constellation of Ursa Minor in relation to the pole for the II century A.D. A fragment of Bode's star chart that he compiled after the Almagest in the XVIII century.

the magnitude of Beta – 2.2, which makes the former a trifle brighter than the latter. However, Ptolemy adhered to the contrary opinion, believing Alpha to be dimmer than Beta ([1339], page 51, Cat # 2).

Calculations demonstrate that in the II century A.D. the distance between the North Pole and Ursa Minor's Beta roughly equalled 8 degrees, whereas the modern North Star, or Ursa Minor's Alpha, was located at the distance of 12 degrees from the pole. Thus, in the II century A.D. the North Star was much further away from the pole than Ursa Minor's beta. The disposition of these stars in the II century A.D. is shown in fig. 11.2, which is a part of the star chart compiled by the famous astronomer Bode in accordance with the Almagest catalogue. The positions of stars and constellations were obviously calculated and indicated for the II century A.D., since Bode appears to have accepted the Scaligerian dating of the "ancient" Ptolemy's lifetime.

Furthermore, the Beta star is located at the centre of Ursa Minor's body, whereas the Alpha is the star at the very tip of Ursa Minor's tail, qv in fig. 11.2. This is precisely how the positions of these stars are described in Ptolemy's Almagest. The North Star, or the modern Alpha, is localised by Ptolemy as "the star at the tip of the tail" ([1339], page 27; also [704], page 224). As for Beta, Ptolemy describes it as "the southernmost star of the rear part" ([1339], page 27), or as "the next star [after Alpha – Auth.] on the tail" ([704], page 224; see also the fragment of Bode's chart in fig. 11.2). As we can plainly see, Beta is located closer to the centre and the back of the figure, which also brings it closer to the top part of the whole figure, if we are to turn Ursa Minor in such a way that it "stands on its feet". Let us now provide a brief review of the above considerations formed into a table.

North Star, or the modern Alpha of Ursa Minor	*The modern Beta of Ursa Minor*
1. Named as a star of the 3rd magnitude order in the Almagest, which makes it dimmer than the Beta. In reality, their magnitudes are almost equal, qv above.	1. Named as a star of the 2nd magnitude order in the Almagest, being one of the constellation's two brightest stars, since only Beta and Gamma were named as stars of the 2nd magnitude order by Ptolemy.
2. In the II century A.D. the North Star lay at a considerable distance from the pole, namely, one of circa 12 degrees.	2. In the II century A.D. the Beta was closer to the pole than the Alpha, and lay at the distance of circa 8 degrees from the pole.
3. The North Star is described as "the star at the tip of the tail" in the Almagest.	3. The Beta tops the back of Ursa Minor – it is located at the very centre of the constellation figure.

Having compared these two columns, we must admit that we believe it to be a psychological impossibility that a catalogue dating from the II century A.D. should begin with the North Star, since there is obviously a much better candidate – namely, the Beta star of the constellation.

N. A. Morozov was perfectly correct to opine as follows: "How can it possibly be true that someone who lived in the second or even the third century, while listing the stars from the north to the south, could begin the list of Ursa Minor's stars with the furthest star from the pole located at the constellation figure's tail, and not the star at the centre, closest to the pole?" ([544], Volume 4, page 202). The situation shall grow

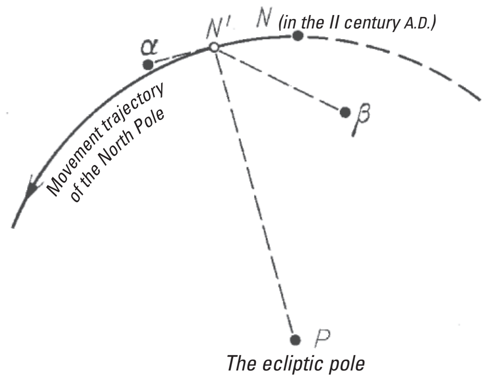


Fig. 11.3. The North Pole moves virtually right towards the Alpha of Ursa Minor, or the modern North Star, moving away from the Beta. The initial location of the North Pole (*N*) is given for the II century A.D.

even stranger if we assume that the star catalogue was compiled by Hipparchus in the alleged II century B.C.

However, everything shall change instantly, with every oddity disappearing, if we abandon the hypothesis that the Almagest was compiled around the beginning of the new era. Let us see whether there are any epochs when it would be perfectly normal for the compiler to begin the catalogue with the North Star. In fig. 11.3 one sees the North Pole (*N*), the ecliptic pole (*P*), and Ursa Minor's Alpha and Beta, as well as the direction of the North Pole's rotation around the ecliptic pole. We disregard the minor oscillations of the ecliptic presently. It is perfectly clear that the situation alters over the course of time. Namely, the Beta star drifts away from the pole, whereas the Alpha star moves in the opposite direction. Fig. 11.3 makes it very obvious that the North Pole moves right towards Alpha, or the North Star, and away from Beta. The initial position of the North Pole (*N*) in the II century A.D. is shown in fig. 11.3. The pole (*N*) rotates around the pole of the ecliptic at the rate of circa one degree per century (the estimate is, of course, rather rough).

We now have a general idea of the time period required for the North Pole to get closer to the North Star than to Beta. We did not aim to make any precise calculations here, since we do not consider this an important dating method for the catalogue; the considerations we're voicing presently have an auxiliary nature. A rough estimate demonstrates that 7-9 centuries later (as counted off the II century A.D.), the Alpha star does indeed become closest to the North Pole. Therefore, we come up with the following comparative table for stars Alpha and Beta, covering the period between the IX-XI century A.D. and our days.

North Star (Alpha)	*Beta star*
1. Star of Ursa Minor closest to the North Pole.	1. Lays at greater distance from the North Pole than Alpha.
2. The tail is the part of Ursa Minor's figure that lays the closest to the pole. See fig. 11.3 and Bode's star chart.	2. The body of Ursa Minor, which comprises the Beta, moves away from the North Pole.
3. Alpha is brighter than Beta. The true brightness of Alpha equals 2.1 (as per photometric measurements). Alpha is the brightest star of Ursa Minor.	3. The true brightness of Beta equals 2.2 (as per photometric measurements). Therefore, Beta is dimmer than Alpha, although Ptolemy claims the reverse to be the case.

It is perfectly obvious that any observer who would compile the catalogue in the timeframe between the IX century A.D. and the present day is most likely to choose Alpha as the first star in his list – this is precisely what the compiler of the Almagest has done. Incidentally, in the XV-XVI century, which is when the Almagest manuscripts were published the most actively, the modern North Star was already the closest to the North Pole, the distance between the two equalling a mere 4 degrees. There was no closer star. In 1900 the distance between the modern North Star and the pole equalled 1 degree 47 minutes, and by 2100 it shall equal 28". After that, the distance shall begin to grow.

And so, by beginning with the North Star, the compiler of the Almagest catalogue provides us with some data about the date of his observations – they cannot predate the epoch of the X-XI century A.D.

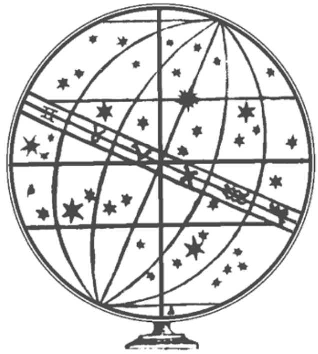
1.3. Oddities inherent in the Latin (allegedly 1537) and Greek (allegedly 1538) editions of the Almagest

The Latin edition of the alleged year 1537, kept in Cologne, and the Greek edition of the alleged year

CL. PTOLOMAEI
PHELVDIENSIS ALEXANDRI-
NI PHILOSOPHI ET MATHEMATICI
excellentiſſimi Phænomena, ſtellarum MXXII. fixarum
ad hanc ætatem reducta, atque ſeorſum in ſtudioſo-
rum gratiam.

Nunc primum edita, Interprete
Georgio Trapezuntio.

¶ Adiecta eſt iſagoge IOANNIS Nouiomagi ad ſtellarum
inerrantium longitudines ac latitudines, cui etiam acceſſere
Imagines ſphæræ barbaricæ duodequinquaginta.
ALBERTI DVRERI.



¶ Excuſum Coloniæ Agrippinæ, Anno M. D. XXXVII.
octauo Calendas Septembres.

Fig. 11.4. The title page of a Latin edition of the Almagest, allegedly dating from 1537.

Nunc primum edita, Interprete
Georgio Trapezuntio.

¶ Adiecta eſt iſagoge IOANNIS Nouiomagi ad ſtellarum
inerrantium longitudines ac latitudines, cui etiam acceſſere
Imagines ſphæræ barbaricæ duodequinquaginta.
ALBERTI DVRERI.

Fig. 11.5. A fragment from the inscription on the title page of an edition that allegedly dates from 1537.

1538, kept in Basel, are considered the most important mediaeval editions of the Almagest ([1024]). See also the list of the Almagest's printed versions in [1024]. The title page of the Latin edition tells us explicitly that the edition in question is the "first", qv in figs. 11.4 and 11.5. We read the following (fig. 11.5):

Nunc PRIMUM edita, Interprete
Georgio Trapeuzuntio.

This leads us to a perfectly justified question. How reliable are the datings of the manuscripts that served as prototypes for the edition of the alleged year 1528 (Trebizond, #36 in the list from [1339], qv below) and the edition of the alleged year 1515 (#35 in the list from [1339]), considered exceptionally rare today? To the best of our knowledge, there is another edition, allegedly dating from 1496, which contains no star catalogue at all. The date indicated on the title page of the Latin edition allegedly dating from 1537 is transcribed as follows: M. D. XXXVII (see fig. 11.4). Pay attention to the dots that separate the Latin letters M and D from the rest. As it was pointed out in Chron1, this transcription can be interpreted in a variety of ways, such as "Magnus Domus XXXVII", or "Magn Dome XXXVII" – "Year 37 of the Great House", in other words. Therefore, we might as well also enquire about the actual dynasty (or Great House), whose reign the mediaeval publisher used for chronological reference.

N. A. Morozov describes the oddities that he had discovered, which made him question the consensual dating of the Almagest, in the following manner: "I … started to compare the latitudes I found [in the Latin book of the alleged year 1537 – Auth.] to their modern equivalents, converting direct ascensions and declinations of stars taken from the Astronomischer Jahrbuch of 1925 into longitudes and latitudes for this purpose. The very first calculation that I had performed for Regulus flabbergasted me completely: the position I came up with corresponded to the XVI century A.D. and not the II – the epoch when the book under study was published, in other words. I proceeded with Virgo's Ear of Wheat and three other bright stars. The result was the same – Ptolemy's longitudes corresponded to the XVI century! … I thought to myself 'How can this be? After all, Bode (whom I still hadn't read in the original) and a host of other astronomers, such as Abbot Montinho, date this book to the second century' … The very next morning … I went to the Pulkovo Observatory in order to compare these amazing results to the first editions of the Almagest kept there … I took the first Greek edition [of the alleged year 1538 – Auth.] off the shelf, and

was amazed to discover that all the longitudes it contained were reduced by the shift on 20 degrees (give or take 10 minutes) as compared to my Latin book; therefore, the time of the catalogue's compilation was shifted backwards by fifteen hundred years, if we are to count the respective longitudes from the point of vernal equinox … My amazement was no longer: Bode had used the Greek edition of 1538 for his calculations, whereas I referred to the earlier Latin edition of 1537. However, I started to wonder about the following: isn't it odd that precession would cover precisely 20 degrees over the period of time that passed between the alleged epoch of Ptolemy and the Greek edition of his book – not 15, 16, 17, 18 or some such, but a whole 20 degrees, with the same variation of give or take 10 arc minutes?" ([544], Volume 4, pages 178-179).

Bode's position is perfectly clear: why would one analyse the Latin "translation" if one had the original (as Bode believed) text in Greek? It was only later that N. A. Morozov first voiced the suspicion that the Latin text of the alleged year 1537 might be the original in reality, the Greek text of the alleged year 1538 being a derivative thereof. Scaligerian chronology claims the reverse to be true.

It could be that the author of the XV, XVI or even early XVII century, who published the alleged "Latin translation" first, hadn't bothered to account for the effect of precession. When it was pointed out to him, he introduced the corrections into the "Greek original", shifting it backwards in time to the II century A.D.

Let us cite the table compiled by N. A. Morozov, which demonstrates the 20-degree longitudinal shift between the Latin and the Greek editions of the Almagest in all clarity, using the Cancer constellation as an example ([544], Volume 4, p. 180). See table 11.1.

However, we may yet encounter objections against the originality of the Latin text allegedly dating from 1537. Our opponents might suggest that in the XVI century Ptolemy's book wasn't published as a document important for the history of sciences, but rather a scientific tractate for immediate use by the scientists and students of astronomy. This application was however hindered by precession, which had rendered the data contained in the "old" catalogue obsolete. Therefore, the translator brought the catalogue "to date", introducing the latest data available in his epoch, or the astronomical data of the XV-XVI century. As for the publisher of the Greek text, which came out the very next year, allegedly in 1538 – he may have decided that the Greek text was no longer needed as a textbook after the publication of the Latin

Ptolemy's star names	*Modern star names*	*Stellar longitudes calculated for 140 A.D. Parentheses contain longitudes from the Almagest version referred to in [1339]*	*Stellar longitudes indicated in the Greek edition of the Almagest allegedly dating from 1538*	*Stellar longitudes given in the Latin edition of the Almagest allegedly dating from 1537*	*Difference between the Latin longitudes and their Greek counterparts*
1 (Manger)	41ε	Cancer 10° 19' (10° 20')	Cancer 10° 20'	Leo 0° 10'	20° (–10')
2	33η	Cancer 8° 18' (7° 40')	Cancer 7° 20'	Cancer 27° 30'	20° (+10')
3	31θ	Cancer 8° 38' (8° 0')	Cancer 8° 0'	Cancer 27° 50'	20° (–10')
4 (Ass)	43γ	Cancer 10° 26' (10° 20')	Cancer 13° 0'	Leo 2° 50'	20° (–10')
5 (Jennet)	47δ	Cancer 11° 36' (10° 20')	Cancer 11° 20'	Leo 1° 10'	20° (–10')
6	65α	Cancer 16° 0' (16° 30')	Cancer 16° 30'	Leo 6° 20'	20° (–10')
7	48ι	Cancer 9° 13' (8° 20')	Cancer 8° 20'	Cancer 28° 10'	20° (–10')
8	10μ	Cancer 2° 21' (2° 40')	Cancer 2° 20'	Cancer 22° 30'	20° (+10')
9	17β	Cancer 7° 10' (7° 20')	Cancer 7° 20'	Cancer 27° 0'	20° (–20')

Table 11.1. The table compiled by N. A. Morozov ([544], Volume 4, page 180). The table demonstrates the shift of longitudes by 20 degrees that makes the Latin edition of the Almagest differ from the Greek, using the constellation of Cancer as an example. In order to render the coordinates to their ecliptic equivalents, one has to bear in mind that the sign of Cancer begins at the 90th degree of longitude in the even Zodiac, and Leo – at the 20th degree, qv in table 2.1.

translation, restoring the initial data introduced by the "ancient" Ptolemy, which date the catalogue to the beginning of the new era. This theory appears to be supported by the title page of the Latin edition of 1537, which bears the legend "rendered to the present moment for the sake of the students" (*ad hanc aetatem reducta, atque seorsum in studiosorum gratiam*) – see fig. 11.4.

This line of argumentation acknowledges the apocryphal nature of the Latin edition (inasmuch as the star catalogue is concerned, at least), but denies the possibility that the Greek version may be apocryphal as well.

The refutation of the above is as follows. All the latitudes contained in the Greek edition of the alleged year 1538 have been made greater systematically, the precision margin turning out 25 minutes higher than that of the Latin edition allegedly dating from 1537, or simply corrected for more precise values. Precession has got nothing to do with it, since it does not affect latitudes whatsoever. The correction is of a circular nature, which means that the entire ecliptic was shifted towards the South by nearly the entire diameter of the Sun. The ecliptic of the Greek edition would thus assume its normal astronomical position, since its plane virtually intersects with the centre of the coordinate system, qv in fig. 11.6. The ecliptic was still "fitting poorly" in the earlier Latin edition of the alleged year 1537, meaning that its plane did not intersect with the centre of the celestial sphere. Thus, the ecliptic was measured poorly in the Latin edition, and much better so in the subsequent Greek edition. What we see is obviously a revision of the Latin original.

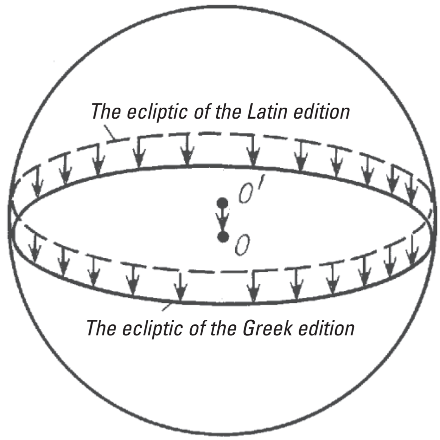


Fig. 11.6. The disposition of the ecliptic in the Greek edition of the Almagest allegedly dating from 1538, as well as the preceding Latin edition allegedly dating from 1537.

Let us provide the following explanatory remark for the attentive reader. The ecliptic of the Latin edition is shown in fig. 11.6 as a dotted circle, and that of the Greek edition – as a simple circle. The "Latin ecliptic" obviously fails to cross the centre of the sphere. The "Greek ecliptic" already occupies a more

Number of Ursa Minor star in the Almagest. Modern names of the stars are given in parentheses	*Latitude indicated in the Latin edition*	*Latitude indicated in the Greek edition. Variants from [1339] are given in parentheses*	*The discrepancy: Greek latitude value with the Latin latitude value subtracted*
1 (1α Ursa Minor)	65° 35'	66° 00'	+25'
2 (23δ Ursa Minor)	69° 35'	70° 00'	+25'
3 (22ε Ursa Minor)	73° 55'	74° 20'	+25'
4 (16ζ Ursa Minor)	75° 15'	75° 20' (75° 40')	+5'(+25')
5 (21η Ursa Minor)	77° 1'	77° 20' (77° 40')	+5'(+25')
6 (7β Ursa Minor)	72° 25'	72° 50'	+25'
7 (13γ Ursa Minor)	74° 25'	74° 50'	+25'
8 (5*A* Ursa Minor)	70° 45'	71° 10'	+25'

Table 11.2. A comparison of the Latin and Greek ecliptic latitudes of Ursa Minor, the first constellation of the Almagest. In the second column one finds the latitudes from the canonical edition, allegedly dating from 1537, and in the second – those taken from the Greek edition of 1538 (presumably), as well as their variants from the canonical version of the Almagest ([1339]) and Toomer's translation ([1538]). The last column contains the difference data for both latitudes.

correct astronomical position, since it is shifted downwards by 25' and made parallel to the "Latin ecliptic". It is possible that the error inherent in the Latin edition was made due to the rough nature of the instruments used for measurements or insufficient accuracy in the conversion of equatorial coordinates into their ecliptic equivalents.

Let us also cite the comparative table of Greek and Latin latitudes (table 11.2) – for example, the ecliptic latitudes of the Almagest's first constellation, namely, Ursa Minor. In the second column we cite the latitudes of the Latin edition allegedly dating from 1537, and in the third – those contained in the Greek edition allegedly dating from 1538, as well as their variants from the canonical version of the Almagest ([1339]) and Toomer's translation ([1358]). The last column contains the values of the discrepancies between latitudes (more specifically, Latin latitudes are subtracted from the Greek).

It is thus quite obvious that the discrepancy between the latitudes indicated by the Latin and the Greek versions (see also the canonical version in [1339] and [1358]) is precisely equal to 25' for every star of Ursa Minor. This is very clearly a shift of 25'. The values of Greek and Latin latitudes were taken from the table cited in [544], Volume 4, page 198.

So, the publisher of the Greek text was "reconstructing Ptolemy's old data" and simultaneously correcting them for greater precision. This contradicts the hypothesis that the Greek text of the alleged year 1538 is the original.

1.4. The star charts of the Almagest

All the Almagest stars are localised in relation to the constellation figures presumably drawn in the sky. In order to use the catalogue, the astronomer must first locate a certain constellation figure in the sky, and then turn to the catalogue in search of a description such as "star at the tip of the tail". In the present example the star in question can be identified as the modern North Star ([704], page 224). "The star above the right knee" in Ursa Major is another example ([704], page 225). And so on, and so forth. We cannot locate any star at all without referring to a star chart with constellation figures drawn upon it. Obviously enough, one might use the numeric coordinate values in order to locate a given star with the aid of measurement instruments; however, this de facto spells as performing the entire measurement process in reverse in order to locate a star by its coordinates. This is a complex and lengthy procedure. It is quite clear that the catalogue was made for the purpose of quick location of stars on the celestial sphere and not the lengthy "restoration procedure" involving reverse calculations.

In this case, two different astronomers referring to the catalogue must possess two perfectly identical star chart copies in order to reconstruct the initial position of "the star above the right knee", for instance, without any ambiguity. If the knee is drawn differently on another copy of the star chart, it is easy to make a mistake. Precise location of stars by body parts of imaginary animals, maintained as a tradition in many countries for many centuries without confusion in actual observation, sans drawn limbs, is only possible insofar as the stars of the first and second magnitude order are concerned – bright stars, that is. Stars of the third magnitude order would already be afflicted by confusion, due to the different astronomers' heterogeneous ideas concerning the shape of the imaginary animals' limbs. Thus, the drawings of animals on star charts played the part of a curvilinear coordinate grid that allowed to define the positions of stars.

At any rate, an astronomer endeavouring to compile a catalogue with the precision margin of 10 minutes, such as the Almagest, must be aware of the paramount importance of using identical constellation figures for different copies of the chart. These copies would be sent to the apprentices and colleagues. As it is stated in the title page of the Almagest's Latin edition, the latter is complemented by 48 star charts engraved by A. Dürer, qv in fig. 11.4. Before the printing press, star charts only contained the brightest stars, and their disposition in relation to the constellation figure varied from one chart to another. It was only after the invention of the engraving technique that a large number of identical copies of a detailed star chart could be manufactured for use by a host of astronomers from different countries.

However, such star charts were right out of the question up until the invention of the mechanical reproduction method in the XV century. Only mass production of absolutely identical copies could jus-

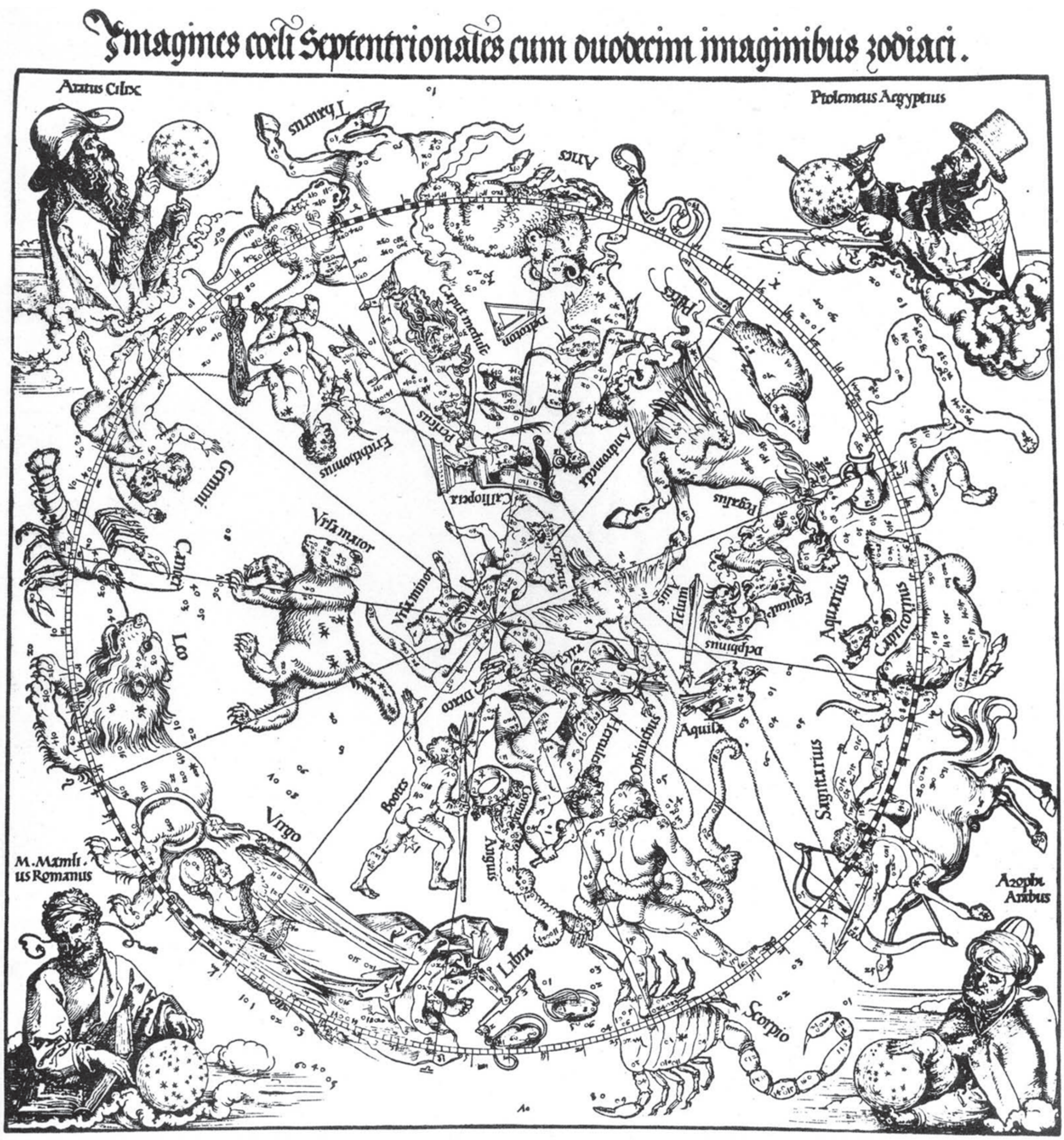


Fig. 11.7. Star chart of the Northern Hemisphere by Albrecht Dürer (1471-1528), allegedly dating to 1527. Taken from [90], page 8.

tify the labour involved in detailed representation of stars up to the 3rd and 4th degrees of magnitude, as is the case with the Almagest. Even if somebody would indeed decide to tackle the Gargantuan job of making a single copy of such a chart before the invention of the printing press, it could never survive for too long – suffice to mention the short lifespan of paper and parchment. The reproduction of such a chart performed with precision sufficient for practical use would mean doing the whole job again from scratch. Albrecht Dürer's star charts are actually the first ones made in great enough detail. In figs. 11.7 and 11.8 we reproduce Albrecht Dürer's star charts of the Northern and the Southern hemisphere allegedly dating

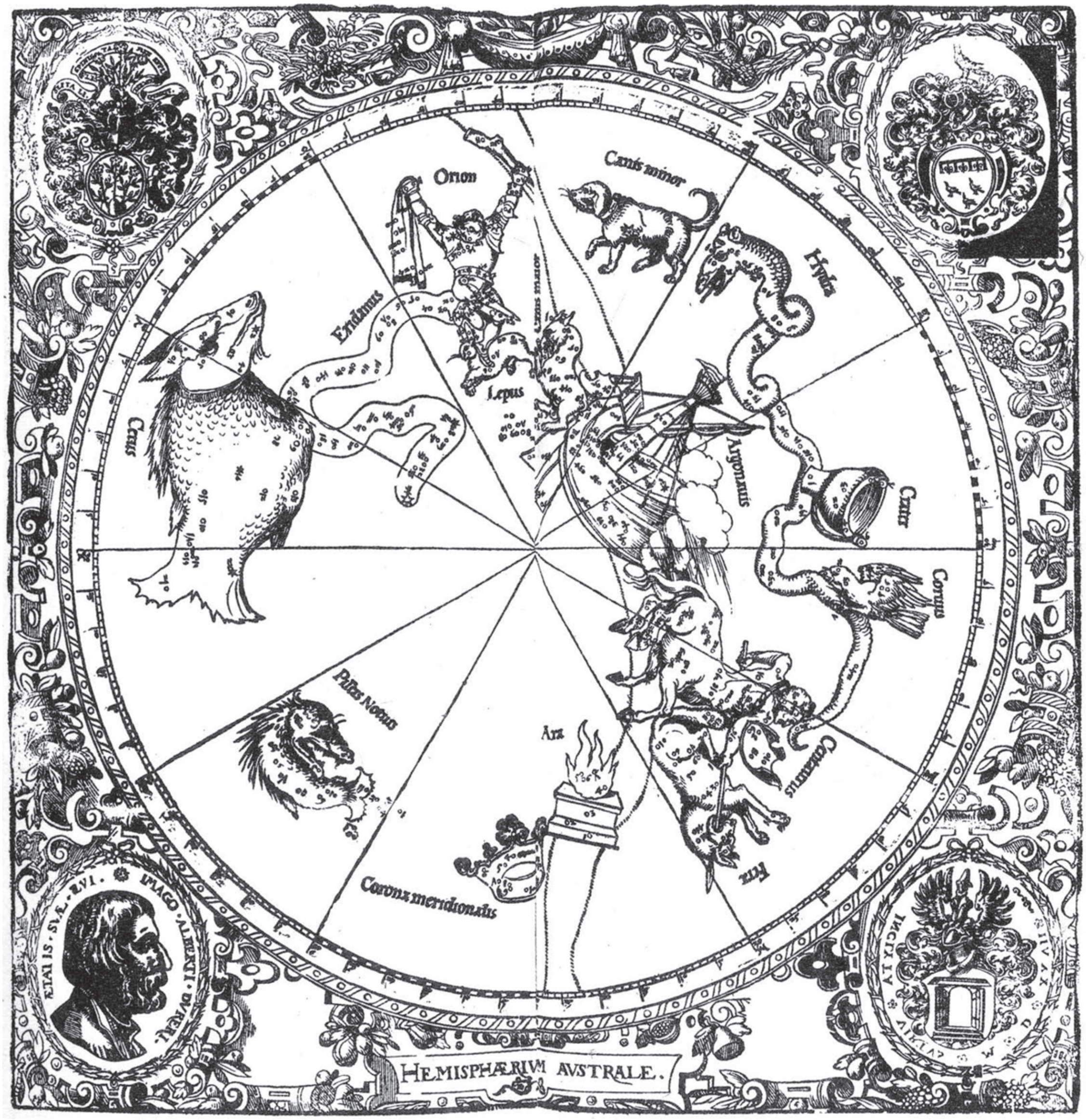


Fig. 11.8. Star chart of the Southern Hemisphere by Albrecht Dürer (1471-1528), allegedly dating to 1527. Taken from [90], page 9.

from 1527. For comparison, in figs. 11.7 and 11.8 we cite the same charts taken from the edition of the Almagest published in the alleged year 1551. It is most noteworthy that the two "Almagest charts" differ from each other – for instance, some of the "ancient" characters are wearing mediaeval clothes in the illustrated maps from the alleged 1551 edition.

Obviously, Dürer's famous star charts, which were engraved in 1515, according to the Latin legend on the engraving, ended up as part of the first Latin edition of the Almagest in the alleged year 1537, long after they were distributed to the Western astronomers as engravings. History of technology tells us that the engraving technique was introduced in

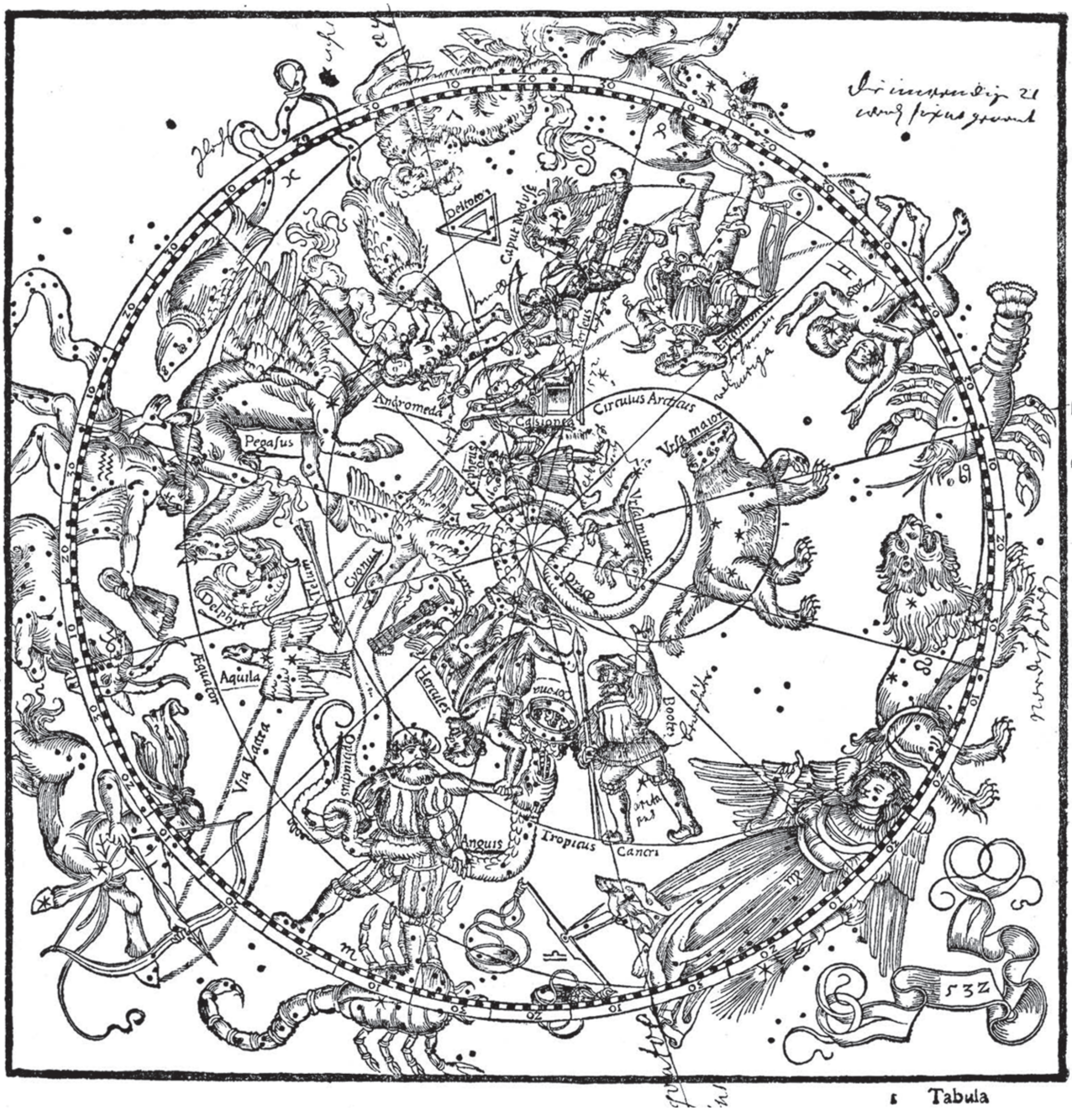


Fig. 11.9. Star chart of the Northern Hemisphere from an edition of the Almagest that allegedly dates from 1551. These charts differ from the edition of presumably 1527 in just one respect, which is rather noteworthy. Constellation figures are wearing mediaeval attire here. Taken from [543], inset between pages 216 and 217.

Europe in the early XV century as a method of replicating drawings, eventually leading to the invention of typeset fonts.

It is believed that the engraving technique was invented in Holland and Flanders, to be imported by France and Italy later on. The oldest dated engraving to date is believed to be the wooden print entitled "St. Christopher", marked with the date of 1423. This precedes Gutenberg's invention of the printing press by some 15-20 years ([544], Volume 4, pages 221-222). As for the fact that printed engravings weren't known previously, it is obvious from the very history of this invention. The first prints were made with the same method that is employed in the manufacture of

Fig. 11.10. Star chart of the Southern Hemisphere from an edition of the Almagest that is allegedly dated to 1551. One must note that we see the figures wear mediaeval clothes. Taken from [543], inset between pages 216 and 217.

rubber stamps today – areas that had to be white were carved into the wood; a wooden plank smeared with paint could make a crude print on paper. However, this method didn't survive for long. Already in 1452 the Florentine goldsmith Tommaso Finiguera took the next step forward. He carved the artwork on a silver plate, covered the latter in a mixture of oil and soot and pressed the plate against a wet cloth. The resulting print was of high enough quality. Tommaso Finiguera repeated the process with sheets of damp paper and discovered that if one kept on rubbing paint into the engraving at a constant rate, an infinite number of prints could be made. This artwork replication method was further perfected by the famous Italian

artist Mantegna (1431-1506; see [797], page 756). He is the author of some 20 plates with mythological, historical and religious scenes – for instance, the seven sheets from the series entitled "Battles of Sea Gods", dating from circa the alleged year 1470.

This is how the manufacture of engravings began – soon also in Germany. A few years later, Albrecht Dürer's (1471-1528) ascension to fame begins – he becomes known as the Nuremberg author of outstanding quality engravings in wood and metal. They were characterised by meticulous design, excellent shading, correct perspectives etc. A whole school of prominent engraver artists came into being.

It would obviously be easier to publish the engravings of star charts (marked 1515 by Dürer) separately than to make them part of a whole illustrated book, such as the Almagest. Dürer himself could have made as many prints as he wanted without the aid of professional book publishers. He wasn't an astronomer (at any rate, these star charts are his only astronomical work). However, not being an observer astronomer, Dürer, who was carrying out the order of some astronomer or publisher, made a number of grave errors in his star charts in order to preserve the elegance of the figures. Let us merely point out the most vivid examples.

The constellation of Ara (the Censer) looks exquisite and perfectly natural in Dürer's rendition – a flat drawing, that is, qv in figs. 11.8 and 11.10. However, if we are to transfer the map's contents to the real celestial sphere, the censer becomes inverted, and the flame faces the wrong direction, making the torch burn upside down (fig. 11.11). What astronomer with experience of real observations could have pictured it in such an awkward manner?

Furthermore, the winged Pegasus also looks seemly and natural in Dürer's flat drawing (figs. 11.7 and 11.9). However, once we transfer the artwork onto the celestial sphere, "Pegasus flies upside down from dawn until dusk, like a wounded bird" ([544], Volume 4, page 209; see fig. 11.12). It is also obvious that no real astronomer of old would ever depict this "winged constellation" in such an awkward manner – hanging upside down on the celestial sphere. This is a blunder of Dürer's. Also, the constellation of Hercules becomes inverted once we project it onto the celestial sphere.

Fig. 11.11. The inverted Ara, as transferred to the celestial sphere from Dürer's map. An astronomer observing the real sky would hardly have drawn it in this manner.

Fig. 11.12. The inverted Pegasus, as transferred to the celestial sphere from Dürer's map. An astronomer observing the real sky would hardly have drawn it in this manner.

All these errors are only observable on the celestial sphere, though, and Dürer's flat drawings conceal them well enough – Pegasus stands on its legs, the Censer's flame is directed upwards etc. It is therefore perfectly clear that their positions were chosen by Dürer in correspondence with the artistic stipulations of a flat drawing. Dürer's errors are perfectly natural. He had a flat sheet of paper at his disposal, after all, and not the curved celestial sphere, and so he was trying to create a certain artistic impression. The manufacture of the engravings obviously took a tremendous amount of labour. Therefore, even if Dürer's client had indeed been horrified by the above absurdities, he had no other option but to sanction the publication of this "art", canonising these brand new detailed star charts. Especially since Dürer, to whom the charts were nothing but a work of art, could have commenced the distribution of the prints himself, without having to wait for the Almagest to come out.

Dürer's "inverted Pegasus" clearly bothered some astronomers – Copernicus, for one. He lived in the alleged years 1473-1543 ([797], page 626). As he was publishing his own star catalogue, which, as we already know (see more details and comparative tables in [544], Volume 4, pages 223-232), was but a slight modification of Ptolemy's Almagest catalogue, Copernicus tried to "rectify" the description of Pegasus. Being too timid to undertake an action as bold as an attempt to draw a corrected version of Dürer's star charts, which Copernicus must have considered a faithful replica of the "ancient Classical charts", presumed lost, he simply changed the order of lines in the description of Pegasus, putting the lowest lines on top and vice versa. More specifically, if the Almagest lists "the star in the mouth (on the snout)" as number 17 in the constellation of Pegasus ([704], page 236), Copernicus names it first ([544], Volume 4, page 228). Au contraire, if the Almagest describes the first star as "the bellybutton star, common with Andromeda's head", Copernicus lists it as the last star of the constellation (#20). However, this "correction attempt" was naïve and doomed from the very start for the simple reason that the mere mechanical replacement of the table's top lines by its bottom lines and vice versa may have corrected the table, but not the actual stellar disposition on the celestial sphere, since the limb-based localization of stars would remain the same all along.

N. A. Morozov wrote as follows: "The attempt of Copernicus to correct the list of a constellation figure's parts and not the figure itself was, of course, extremely naïve, but the fact remains: he didn't make any alterations in the Almagest numeration for any other constellation" ([544], Volume 4, page 225). What we see is a vestige of the undercover struggle between the common sense of the XVI century astronomers and the astronomical absurdity of certain fragments of Dürer's star charts, sanctified by Ptolemy's authority.

Acknowledging Dürer's authorship of all the absurdities inherent in the disposition of certain constellations, we come up with the implication that any constellation drawing that repeats Dürer's errors must postdate Dürer. Now let us revert to the Almagest.

Once again, let us reiterate that the locations of dim stars are described verbally in the Almagest – "in the mouth of Pegasus", "above the left knee", "on the horn of Aries" and so on. The text of the Almagest states it directly that the descriptions in question refer to Dürer's star charts (comprised in the Almagest) explicitly. Indeed, let us return to the constellation of Pegasus. The Almagest describes the first star of this constellation as "the bellybutton star", whereas the "star in the mouth" is one of the last ones listed (#17; see [704], page 236). Since the Almagest catalogue lists the stars from the north to the south, the "bellybutton star" must lay further to the north. Indeed, the Almagest indicates its latitude as 26 degrees. The "star in the mouth" lays further south; its Almagest latitude equals 22 degrees and 30 minutes ([1358], page 358). Therefore, the author of the Almagest is moving in the right direction – from the North to the South, thus confirming the awkward inverted position of Pegasus. We see this to be the case with other constellations as well. Therefore, the author of the Almagest definitely refers to Dürer's star charts as attached to the Almagest.

And so, the compiler of the catalogue and the author of the Almagest refers to the star charts that comprise Dürer's absurdities. Consequently, all the verbal descriptions in question could only end up as part of the Almagest text after 1515. This leads us to the hypothesis that not only the star catalogue, but

also a number of other important chapters of the Almagest (as we know them today) were created or edited in the XVI century the earliest – possibly as late as the early XVII century.

Each of the oddities listed above can be explained within the paradigm of Scaligerian chronology with greater or lesser ruses and allowances. Yet their combination proves too heavy to allow any substantial refutation of the obvious evidence that the main part of the Almagest must be dated to the Renaissance epoch, or even the XVI-XVII century.

N. A. Morozov writes as follows: "All of the above makes me consider the Almagest a comprehensive collection of all the astronomical observations and knowledge to have accumulated between the definition of the 12 zodiacal constellations in the beginning of the new era and the XVI century; individual observations contained in the book must have been made hundreds of years ago. The objective of any serious researcher of this book is to date individual pieces of information that it contains to one century or another" ([544], page 218).

Hipparchus and Ptolemy may well have existed as real astronomers – however, their lifetimes must apparently be dated to a much later epoch. Hipparchus and Ptolemy may have been active in the epoch of the XIII-XVI century A.D. We have already voiced the hypothesis that the "ancient Hipparchus" might be a mere phantom reflection of the famous astronomer Tycho Brahe (1546-1601). The Almagest was published relatively soon after its completion in the XV-XVI century; it is most likely to have been edited in the epoch of the XVI-XVII century. The chronologists of the Scaligerian school misdated the Almagest to deep antiquity – most likely, the erroneous dating was deliberate.

Other mediaeval star catalogues (such as the catalogue of Al-Sufi, qv above) present us with similar problems.

2. THE ALMAGEST AND HALLEY'S DISCOVERY OF PROPER STAR MOTIONS

Today it is believed that proper star motions were first discovered by Edmond Halley in 1718. P. G. Kulikovskiy reports the following in his "Stellar Astronomy": in 1718 "E. Halley (1656-1742), having compared contemporary positions of Arcturus, Sirius and Aldebaran to their positions in the catalogue of Hipparchus, discovered the proper motion rates of these stars: over the course of 1850 years [under the assumption that the catalogue of Hipparchus had already been dated to the II century B.C.: 1718 + 132 = 1850 years – Auth.], the ecliptic longitudes of these stars altered by a shift on 60', 45' and 6', respectively" ([453], page 219). The longitudes in question have been rendered to a single epoch.

The first question that we have can be formulated as follows. How could Halley discover the proper motion of Aldebaran? The matter is that the time interval in question (presumably, around 2000 years) changed the position of Aldebaran by a mere 6' which is known to us from modern sources. However, the precision margin of Ptolemy's catalogue (based on the catalogue of Hipparchus) equals 10', no less. It is pointless to discuss an effect whose influence is too small for the instruments to measure, not to mention the fact that the de facto precision of the measurements made by Ptolemy and Hipparchus is a great deal lower than 10'. So how could Halley possibly discover the proper motion of Aldebaran, a star whose position altered by a mere 6' over the course of 2000 years?

Another question is as follows. What proper motion rates did Halley ascribe to Arcturus and Sirius? The same book of P. G. Kulikovskiy reports the following: "In 1738 G. Cassini (1677-1756) calculated the precise proper motion rate of Arcturus, having compared his measurements to the observations of J. Richet (? – 1696) made 60 years earlier" ([453], page 219). Therefore, Halley's estimate of the proper motion rate of Arcturus wasn't "precise". His calculations for Sirius must have been even less precise, since the star in question is slower than Arcturus.

It would be apropos to mention that Halley was by no means the first to consider the possibility that the stars might be mobile. This issue was discussed heatedly by the astronomers of the XV-XVI century A.D., long before Halley. Moreover, in Scaligerian chronology, the first such enquiry was made in "deep antiquity" – some 2000 years before Halley. Apparently, the question was formulated by none other but the "ancient" Hipparchus, or Tycho Brahe, in our reconstruction.

Pliny the Elder, the famous Roman historian and natural scientist (allegedly 23-79 A.D.) wrote: "Hipparchus … studied the new star that appeared in his age; its mobile luminosity [the star in question might be a comet – Auth.] led him to the idea that celestial bodies that we consider immutable might move as well. He decided to undertake an endeavour that would be bold even for a god – to list the stars for posterity and to count them with the aid of instruments of his own invention, which made it possible to measure the position and magnitude of individual stars. This way it would be easy to tell whether or not the stars could disappear and reappear, move around or grow brighter or dimmer. He bequeathed the sky to his descendants in hope that someone might claim the legacy one fine day" (quoted according to [98], p. 31).

It is believed that the possibility of stellar motion was also discussed by Ptolemy. Ptolemy made a special study of this issue, which was crucial to him, and came to the conclusion that the stars were immobile. We know this conclusion to be erroneous.

Therefore, we can by no means credit E. Halley with being the first to raise the issue of stellar motion.

But why didn't any earlier astronomers compare the positions of the stars on their own celestial sphere to those indicated in the Almagest in order to spot proper motions? After all, the very idea of such a calculation can be traced back to Ptolemy, and was hardly a novelty for the mediaeval astronomers. Such attempts would be logical, and may well have resulted in the discovery of proper star motions – for instance, the errata inherent in Ptolemy's star position estimates could easily be mistaken for proper star motions. Early XVII century astronomers could have calculated the proper motion rates of Arcturus and Sirius a century before than Halley, using the catalogue of Tycho Brahe for reference. The latter is believed to have possessed an error margin of 1' and usually dated to 1582-1588 A.D. We have to remark that the error margin of Tycho Brahe's catalogue that we have calculated actually equals 2' – 3', qv above. Therefore, the astronomers of the XVI-XVII century could have easily compared the catalogue of Tycho Brahe with the "ancient" Ptolemy's Almagest – given the correctness of the Scaligerian dating ascribed to the latter.

Let us assume the stance of the XVI-XVII century astronomers. It is a priori clear that they could only have assumed one of the two possible stances on Ptolemy's Almagest as related below.

First let us assume that these astronomers already agreed with the position of Scaliger and Petavius, the XVI-XVII century chronologists, according to whom the reign of Emperor Antoninus Pius began in 138 A.D., which is the observation year as indicated in the Almagest. In this case they must have made an attempt of discovering proper star motions, using this "aged" 1500-2000-year-old catalogue for reference. Arcturus would be a likely choice, since it is the brightest star of the northern sky. However, Scaligerian history of astronomy records no such attempts anywhere in the XV-XVII century A.D., for some reason, although they should have led the astronomers of the XV-XVII century to the same conclusion that was made by Halley in the XVIII century, namely, that Arcturus was mobile, at the very least.

Now let us assume that the astronomers of the XVI-XVII century considered the Almagest to be a comparatively recent document, dating from the XII-XVI century A.D., for instance, or, alternatively, as a document with no known compilation date. In this case, their attitude would be substantially different. If the astronomers believed the document to be of a relatively recent origin, the short period of time elapsed since its creation may have been considered insufficient for the proper stellar motions to be noticed. Furthermore, if the catalogue was considered mediaeval, the low precision of the Almagest scale was no secret for professional astronomers, likewise the resulting impossibility of conducting any useful calculations for individual stars. No calculations could be made for a catalogue without any known compilation date, either.

Let us reiterate that the history of astronomy mentions no attempts of the XVI-XVII century astronomers to discover proper star motions with the aid of the Almagest. Therefore, we can formulate the hypothesis that these astronomers did not deem the Almagest a sufficiently old document with a precise date.

Thus, a serious researcher of the XVI-XVII century A.D., who regarded the Almagest as a mediaeval document must have arrived at the conclusion that the precision of the Almagest coordinates was insufficient for the discovery of proper star motion. On the

other hand, had the Almagest been considered as an ancient document of the II century A.D., for instance, it is utterly improbable that the idea of using it for reference in proper star motion research would wait for Halley to stumble upon it in the XVIII century, taking into account the importance of the issue as seen by the mediaeval astronomers.

Now let us try and explain why it was already possible to make the conclusion concerning the proper motion of certain stars, such as Arcturus and Sirius, in the epoch of Halley, although no rate estimate could yet be made with any degree of precision at all.

Apparently, the first more or less precise star catalogue was compiled by Tycho Brahe, alias "Hipparchus". Arcturus and Sirius had shifted on circa 3' and just over 2', respectively, over the 100-120 years that lay between Tycho Brahe and Halley. Somebody with a precise catalogue of star positions compiled for the epoch of the early XVIII century could already suspect the mobility of Arcturus and Sirius, notwithstanding that the low precision of Tycho Brahe's catalogue didn't permit any motion rate estimates. It turns out that a more reliable catalogue did in fact appear in the early XVIII century – the catalogue of John Flamsteed (1646-1719), which Halley was using de facto even before its publication (some intermediate version that he had procured by proxy of Isaac Newton, who was conducting his chronological research right around that time).

Therefore, we are of the opinion that Halley's conclusion about the proper motion of Arcturus, Sirius and Aldebaran resulted from a comparison of Flamsteed's catalogue to the catalogue of Tycho Brahe.

The "proper motion rate" of Aldebaran that he indicates also receives a natural explanation. Halley was using an intermediate version of Flamsteed's catalogue, which contained certain errata – affecting the position of Aldebaran, for instance. Flamsteed himself opined that his catalogue wasn't ready for publication just then. It is known to us that Halley explicitly enquired about the position of Aldebaran, qv in his letter to A. Sharp written on 13 September 1718 and quoted in F. Bailey's book ([1023]).

Why did Halley refer to Ptolemy's Almagest as the cornerstone of his research, at any rate, and not the catalogue of Tycho Brache, for one? Apparently, in Halley's epoch the Scaligerian dating of the Almagest as "calculated" by Scaliger and Petavius (the alleged year 138 A.D.) was already canonised. Halley's reference to the Almagest and not the catalogue of Tycho Brache was aimed at adding some credibility to his discovery – Almagest data made the shifts of stellar positions look more substantial. The shift of Arcturus as calculated with the aid of Tycho Brache's catalogue would amount to a mere 3', which is next to nothing, given the nominal precision of 1' (actually, 2' – 3') claimed for Brahe's catalogue. But if he used Ptolemy's catalogue in order to calculate the shift of Arcturus (a catalogue compiled in the epoch of circa X-XI century A.D., as we realise now), the value of the shift would be more ostensible. Halley appears to have compared this shift value to the nominal 10' precision of the Almagest, ignoring the issue of the actual precision of star coordinates in the Almagest.

The above considerations once again lead us to the thought that in the XVI-XVII century the Almagest may not have yet been regarded as an ancient document fifteen centuries old. However, in Halley's epoch (the early XVIII century), the erroneous chronology of Scaliger and Petavius was already the official version, with the "amazing antiquity" of the Almagest made canonical.

3. THE IDENTITY OF THE "ANCIENT" EMPEROR PIUS, IN WHOSE REIGN MANY OF PTOLEMY'S ASTRONOMICAL OBSERVATIONS WERE PERFORMED. His geographical and chronological localisation

Let us illustrate how the system of three chronological shifts that was discovered by A. T. Fomenko in CHRON1 helps us with the solution of certain chronological problems. We must remind the reader that the "Almagest" mentions the observations to have been conducted in the reign of the Roman emperor Antoninus Pius ([1358], page 328). Modern historians believe this emperor to be "ancient", and date his reign to the alleged II century A.D. However, the astronomical data contained in the Almagest clearly indicate that the book was compiled and brought to completion in the XI-XVII century A.D.

There is no contradiction here. Let us consider the chronological shift map as reproduced in CHRON1

Fig. 11.13. A portrait of Maximilian Augustus Pius (1440-1519) done by Albrecht Dürer. Most of the astronomical observations included in the Almagest were performed during his reign. His phantom reflection is the "ancient" emperor Antoninus Pius. Taken from [1234], engraving #318.

and CHRON2. A summary shift of 1053 + 333 = 1386 years the "ancient" emperor Antoninus Pius "travels forward in time" and winds up in the XVI century A.D. (more precisely, his reign falls over the period between 1524 and 1547 A.D.). Let us remind the reader that the Scaligerian dating of his reign is as follows: 138 – 161 A.D. ([797], page 65).

It is most remarkable that the "ancient Antoninus Pius" is transferred to the very epoch of the first editions of the Almagest. The first Latin edition dates from 1537, and the Greek – from 1538. Trebizond's "translation" dates from 1528 – and so on, and so forth. Indeed, all these publications appear to have come out in the reign of "Emperor Pius" as mentioned in the Almagest. The author of the Latin edition must have acted in good faith when he made the reference to the ruler regnant during the epoch of the observations.

We have an excellent opportunity to conduct an in-depth study of this issue. Given the superimposition of the Roman Empire of the I-III century A.D. over the Roman Empire of the X-XIII century A.D. and the Habsburg Empire of the XIV-XVII century, we may attempt to name a Habsburg Emperor named Pius. The epoch that immediately precedes the first editions of the first Almagest editions, or the early XVI century, is "covered" by the reign of the famous emperor Maximilian I (1493-1519). If the publication of the book took place right after its creation, all the astronomical observations in question must have taken place during his reign. The emperor's full name contains the following formula: Maximilian Kaiser Pius Augustus (see Albrecht Dürer's engraving in fig. 11.13). A slightly different version of the same engraving by Dürer is reproduced in [304], Volume 2, page 561. See also CHRON1, Chapter 6.

We are thus led to the thought that many of Ptolemy's astronomical observations were carried out in the reign of the Habsburg Emperor Maximilian Pius Augustus in the late XIV – early XV century.

4. SCALIGERIAN DATINGS OF THE MANUSCRIPTS AND THE PRINTED EDITIONS OF THE ALMAGEST

Let us compare the dating of the Almagest star catalogue that we came up with (VII-XIII century A.D.) to the Scaligerian datings of the surviving Almagest manuscripts. We shall also cite the Scaligerian dates of the first printed editions of the Almagest.

We have used the work of Peters and Knobel for reference ([1339]), which contains a full list of all the oldest Greek, Latin and Arabic manuscripts of the Almagest. We have constructed a chronological diagram, qv in fig. 11.14, and indicated the Scaligerian datings of all these texts on the horizontal time axis. Apart from that, the diagram reflects the interval in the astronomical dating of the Almagest catalogue that we have calculated.

In fig. 11.15 we also cite the Scaligerian lifetimes of certain mediaeval characters associated with astronomy, the findings of the ancient manuscripts, and the establishment of the consensual chronological system.

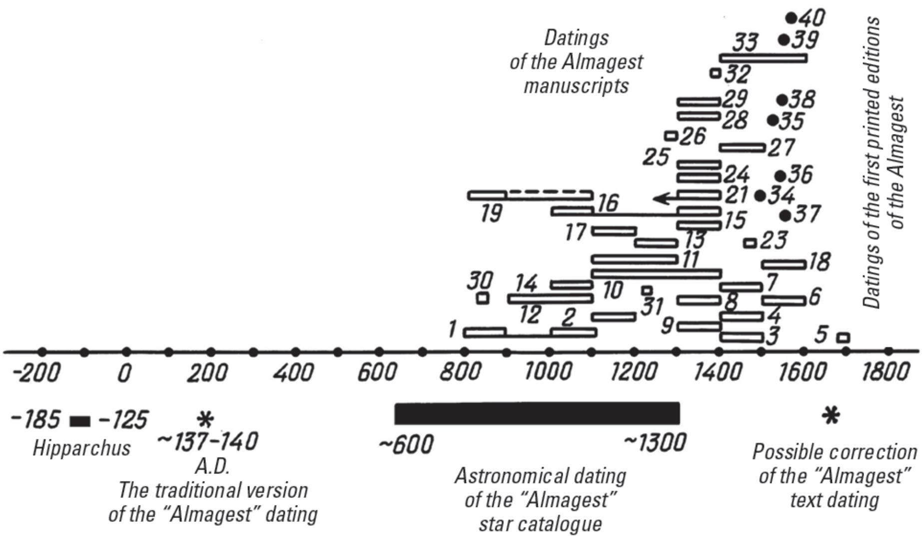


Fig. 11.14. The distribution of Scaligerian Almagest manuscript datings on the time axis. Compiled according to the materials from [1339].

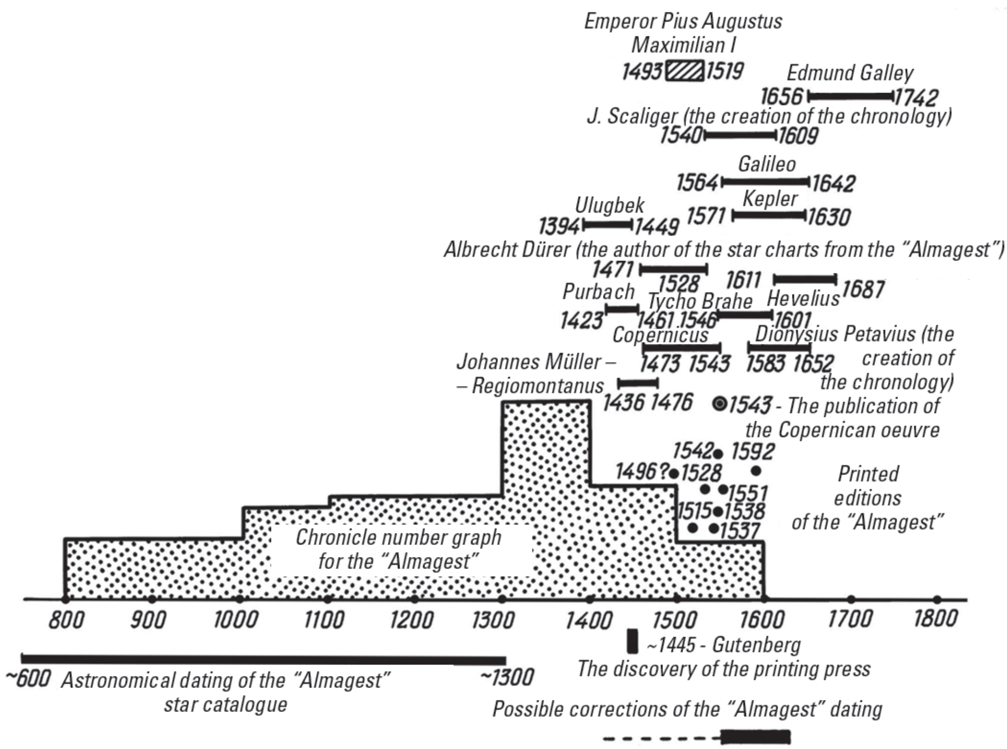


Fig. 11.15. Almagest chronicle dating distribution density graph. Compiled in accordance with the materials from [1339]. Additional chronological data related to the Almagest are also indicated.

4.1. Greek manuscripts of the Almagest

1) Paris Codex 2380. This manuscript (likewise text #19, qv below) is considered the oldest Almagest manuscript ([1339], page 19). Presumably, this codex was initially kept in Florence, which is whence Catherine Medici probably took it to Paris. After her death, it ended up in the library (the modern National Library). It bears the golden seal of Henry IV, allegedly regnant in 1053-1106 A.D. There is no unanimous opinion about the dating of this Almagest copy, qv below. We must particularly emphasise the following circumstance of a general nature. The dating of the Almagest manuscripts is often complicated by the fact that they seldom bear any chronological references. In this case, the seal of Henry IV can be regarded as such. We are thus brought to the issue of estimating the reign dates of Henry IV. Scaligerian history ascribes this ruler to 1053-1106 A.D. This is the very reason why the oldest manuscript copy of the Almagest is dated to the XI or the early XII century A.D. However, given the dynastic parallelism between the Holy Roman Empire of the X-XIII century and the Habsburg Empire of the XIV-XVII century as discovered by A. T. Fomenko and described in CHRON1 and CHRON2, it would be more apropos to date this Almagest manuscript to the epoch of the XV-XVI century, since "Henry IV" is but a phantom reflection of Frederick III (1440-1493). The chronological shift forward in time shall roughly equal 360 years in this case.

Nowadays the dating of manuscripts is occasionally performed with the aid of palaeography, or the "method" based on the graphical particularities of how certain letters are transcribed. It is presumed that each century can be characterised by a certain unique manner of writing letters. We shall refrain from a more in-depth analysis of this dating method, and simply point out the fact that it is very vague and arbitrary. Moreover, this "method" is wholly dependent on the Scaligerian chronology, which is used a priori. Such "palaeographic considerations" led Halma to the suggestion that the Almagest manuscript be dated to the VII or the VIII century A.D. Nevertheless, consensual Scaligerian history agrees to date the manuscript in question to the IX century – also on the basis of "palaeographic considerations", as it turns out. This dating is discussed in [1339], page 19. Let us mark both dates in our diagram – the IX century A.D., according to the palaeographic hypothesis, and the XI-XII century A.D. (judging by the seal of Henry IV).

Let us reiterate that our reconstruction implies the correct dating to pertain to the epoch of the XV-XVI century.

As we proceed with the descriptions of the other manuscripts, we feel obliged to state that [1339] most unfortunately fails to discuss the principles of dating manuscripts to one century or another. Most of the information that does actually concern dating once again happens to be of a palaeographic nature. Therefore, for the most part, we shall formally indicate the presumed dating of the manuscript in question accepted as consensual in Scaligerian history. Most Scaligerian datings are accompanied by the word "approximate" in [1339], which once again reveals the sheer complexity of the issue.

2) Paris Codex 2390. Approximately dating from the alleged XII century A.D.

3) Paris Codex 2391. Approximately the alleged XV century A.D.

4) Paris Codex 2392. Approximately the alleged XV century A.D. Incomplete text, a very poor copy.

5) Paris Codex 2394. Copy made in 1733.

6) Vienna Codex 14. Approximately the alleged XVI century A.D.

7) Venice Codex 302. Approximately the alleged XV century A.D.

8) Venice Codex 303. Approximately the alleged XIV century A.D.

9) Venice Codex 310. Approximately the alleged XIV century A.D.

10) Venice Codex 311. Zanetti's catalogue dates it to approximately the XII century A.D. However, Peters is of the opinion that the dating must be replaced by a substantially more recent one. According to Morelli, this manuscript is a later copy of Venice Codex 313, which is approximately dated to the alleged X or XI century A.D., or even a copy of Venice Codex 303, dated to circa the alleged XIV century A.D. ([1339]). Once again, this example demonstrates the ambiguity of the Scaligerian manuscript datings.

Having summarised all the above opinions, we come up with the following interval of Scaligerian datings: between the alleged XII and XIV century A.D.

11) Venice Codex 312. Zanetti suggests the XII

century A.D. as the approximate dating, and Morelli – the XIII century A.D.

12) Venice Codex 313. Zanetti's approximate dating is the X century A.D., whereas Morelli suggests the XI century.

13) Laurentian Codex. Pluteus 28, 1. Approximately the alleged XIII century A.D.

14) Laurentian Codex. Pluteus 28, 39. Approximately the alleged XI century A.D. However, it only contains Books VII and VIII.

15) Laurentian Codex. Pluteus 28, 47. Approximately the alleged XIV century A.D.

16) Laurentian Codex. Pluteus 89, 48. Approximately the alleged XI century A.D. An excellently written manuscript – however, it has got a lot in common with Venice Codex 310, which is dated to the alleged XIV century A.D.

17) Vatican Codex 1038. Approximately the alleged XII century A.D.

18) Vatican Codex 1046. Approximately the alleged XVI century A.D.

19) Vatican Codex 1594. Dated to the alleged IX century A.D. This is the best Greek manuscript of the Almagest. Unfortunately, [1339] does not mention the reason for this particular dating. It is however pointed out that the manuscript in question has common characteristics with Venice Codex 313, "which testifies that they share a common background" ([1339], page 21). However, the manuscript of Venice Codex 313 is dated to either the X or the XI century A.D., qv above.

20) Vatican Codex, Req. 90. According to Peters and Knobel, "this codex isn't likely to be very old" ([1339], page 21). However, they fail to provide its dating for some reason, which is why we cannot put it on our chronological map.

21) Bodleian Codex 3374. Allegedly predating the XIV century A.D. A perfect copy, beautifully written, sans variants.

4.2. Latin manuscripts of the Almagest

22) Vienna Codex 24 (Trebizond). An excellent codex under the title of "Magnae compositionis Claudii Ptolemae i libri a Georgio Trapezuntio traducti". It is believed to be a Latin translation of a Greek manuscript. Trebizond's translation was used for the Almagest edition dating from the alleged year 1528. At the end of the codex we see the legend "Finis 17 Marcii, 1467", which stands for "finished on 17 March 1467".

23) Laurentian Codex 6. Dated to the interval between the alleged years 1471 and 1484 A.D. Believed to be a translation from the Greek. The writing is meticulous and clear.

24) Laurentian Codex 45. Approximately dated to the alleged XIV century A.D. A beautifully written manuscript that contains many variants. This manuscript is believed to be a copy of a translation from the Arabic, likewise the next three.

25) The British Museum Codex. Burney 275. Dates from circa the alleged XIV century A.D. Believed to be a translation of the Arabic. This is an excellent copy of the Almagest, beautifully written.

26) The British Museum Codex. Sloane 2795. Considered a translation from the Arabic. Approximately dated to 1300 A.D. according to Thompson, and unlikely to predate 1272 A.D. Written well enough, but with numerous errata.

27) Crawford Codex. Roughly dated to the alleged XV century A.D. An excellent manuscript (presumably translated from the Arabic).

28) New College, Oxford No 281. A rather imperfect copy of the translation made by Gerard of Cremona, which permits to date it to the XIV century A.D. the earliest.

29) All Souls College, Oxford No 95. Once again, a translation of Gerard of Cremona; however, some of the books have been omitted. Unlikely to predate the alleged XIV century A.D.

4.3. Arabic manuscripts of the Almagest

30) Laurentian Codex 156. A very meticulously written manuscript. Believed to be a copy of the translation made by al-Mamon around the alleged year 827 A.D.

31) British Museum 7475. This copy of the Almagest is incomplete. It is dated to year 615 of Hijrah, which yields the alleged year 1218 A.D. in accordance with the consensual conversion of Hijrah (Hejira, Hegira etc) dates into A.D. equivalents. Many longitudes and latitudes are at odds with other manuscript (!).

32) Bodleian Arabic Almagest, Pocock 369. Dates

from the year 799 of Hijrah, or the alleged year 1396 A.D. A well-written copy.

33) British Museum Arabic Manuscript, Reg. 16, A. VIII. A beautiful manuscript approximately dated to the alleged XV or XVI century A.D.

We shall depict the Scaligerian datings of all the Almagest manuscripts mentioned above as white intervals in our chronological diagram (fig. 11.14), which correspond to the temporal limits of a given manuscript's possible dating. For instance, the interval that begins in 1272 and ends in 1300 corresponds to the interval of possible datings for Manuscript 26. If we only know the alleged century that the dating in question is ascribed to, the corresponding white interval on our diagram shall cover the entire century in question.

Now let us list the first printed editions of the Almagest. In order to avoid confusing their datings with those of the manuscripts in the diagram, we shall mark them with black dots, accompanied by their numbers in our list.

4.4. The first printed editions of the Almagest

Let us cite some data concerning the first editions of the Almagest that N. A. Morozov gathered from the book archive of the Pulkovo Observatory ([544], Volume 4).

34) Joannis de Monte Regio et Georgii Purbacho Epitome in Cl. Ptolemaei magnam compositionem. Venice, allegedly 1496 (?).

This is what Morozov observes about this edition: "There is, for example, a printed book by John Regiomontanus and George Purbach entitled 'A Brief Version of the Magnum Opus of Claudius Ptolemy', which bears the legend 'Venice, 1496', if my sources are correct" ([544], Volume 4, pages 218-219). According to the information available to the authors of the present book, this edition only contains the text of the Almagest and no tables, which means it doesn't include the star catalogue. See also [544], Volume 4, pages 195-196.

35) Almagestu Cl. Ptolemaei Phelusiensis Alexandrini. Anno Virginei Partus 1515 ([544], Volume 4, pages 195-196). This Latin edition was published by Liechtenstein in Venice in 1515. Bailey ([1024]) believes it to be translated from the Arabic, unlike the 1537 edition, which he considers a translation from the Greek. The edition dating from the alleged year 1515 is exceptionally rare – according to Bailey, Laland saw this book, which had existed as a single copy kept by the Royal Astronomical Society in London. N. A. Morozov reports that it was also part of the Pulkovo Observatory collection.

36) Claudii Ptolemae I Phelusiensis Alexandrini. Anno Salutis, allegedly 1528, Venice, translated by Trebizond. A copy is kept in the archives of the Pulkovo Observatory. We have studied the star catalogue of this edition alongside the catalogue cited by Peters and Knobel in [1339]. The results that we got from the edition of 1528 coincide with the results of our analysis of the catalogue contained in [1339].

The two most famous editions of the Almagest are as follows: the Cologne edition of the alleged year 1537 (Latin), and the Basel edition of the alleged year 1538 (Greek).

37) The Latin edition allegedly dating from 1537: Cl. Ptolemae i. Pheludiensis Alexandrini philosophi et mathematici excellentissimi Phaenomena, stellarum MXII. Fixarum ad hancae tatem reducta, atque seorsum in studiosorum gratiam.

Nunc primum edita, Interprete Georgio Trapezuntio.

Adiecta est isagoge Ioannis Noviomagi ad stellarum inerrantium longitudines ac latitudines, cui etiam accessere Imagines sphaerae barbaricae duodequinquaginta Alberti Dureri. Excusum Coloniae Agrippinae [presumably identified as the modern city of Cologne – Auth.], Anno M. D. XXXVII, octavo Calendas Septembres.

38) The Greek edition of the alleged year 1538: Κλ Πτολεμαΐου Μεγάλης Σύνταξεως Βίβλ. ΙΓ. Θεώνος Ἀλεξανδρεώς εΐς τά αΰτά ύπομνηατών Βίβλ. Ι.Α. (Claudii Ptolemaei Magnae Constructionis, id est perfectae coelestium motuum pertractationis Lib. XIII. Theonis Alexandrini in eosdem Commentariorum Libri XI. Basileae [Basel – Auth.] apud Ioannem Walderum An. 1538. C. puv. Caes. Ad Quinquennium.)

39) The second Latin translation of the edition dating from the alleged year 1542 ([544], Volume 4, pages 195-196).

40) The third Latin translation of the edition dating from the alleged year 1551 ([544], Volume 4, pages 195-196).

41) Claudii Ptolemaei inerrantium stellarum Apparitiones, et significationum collectio. Federico Bonaventura interprete. Urbini 1592.

Let us now mark the interval between 600 A.D. and 1300 A.D. on our chronological diagram (fig. 11.15) – the astronomical dating of the Almagest star catalogue that conforms to our results pertains thereto. It is very obvious that the interval in question concurs well with the sum total of the datings of the surviving Almagest manuscripts and the first printed editions of the work in question. The very multitude of manuscripts, especially from the XIV century onwards, might indicate that the Almagest was created during that epoch, and instantly started to propagate as an important scientific oeuvre regarded as an actual scientific textbook and not a vestige of the history of astronomy. It was a collection of methods applicable to the solution of actual astronomical, navigational and likewise problems. Such concurrence between our astronomical dating and the independent information concerning the distribution of the surviving Almagest manuscripts' datings seems to be the furthest thing from a chance coincidence to us.

Basically, it turns out that the Almagest did not lie as a dead weight for many centuries that are presumed to have passed between the beginning of the New Era and the Renaissance epoch. On the contrary, its creation was immediately followed by its introduction into scientific circulation – there were many copies and lots of commentaries; finally, the first large-scale printed editions came out in the XVI-XVII century A.D. Let us note that handwritten books by no means became an anachronism after the invention of the printing press (see CHRON1, Chapter 1:12 for more details). Scribes and copyists kept on making copies of manuscripts for decades to follow – sometimes even copying printed editions. This is very easy to explain – in the very beginning, handwritten copies of manuscripts were cheaper to manufacture than printed versions. The production of handwritten copies ground to a halt only when the prices of printed books got sufficiently low. It is therefore possible, that some of the Almagest manuscripts considered very old today (predating the epoch of the printing press, in other words, and thus presumably created between the X and the middle of the XV century A.D.) may have been written as late as in the XVII-XVIII century A.D.

It would be apropos to cite a number of known facts here, which clearly demonstrate that the handwritten book survived the early days of printing by a long while. See [740], pages 19-25, for more details.

The library of John Dee, an English mathematician and astrologer of the XVI century, contained 3000 handwritten books (amounting to 4000 copies in total, qv in [740], page 56). That is, the majority of the books in Dee's collection were handwritten.

The scribes of the Greek monasteries attained a special renown – and that already in the epoch of printing. An important detail is that many such copies were made from printed books ([740], page 120).

4.5. Questions concerning the Scaligerian datings of the Almagest manuscripts

Let us revert to the description of tables in figs. 11.14 and 11.15. Fig. 11.15 contains graphical representations of auxiliary data useful for the reconstruction of the correct Almagest chronology.

Johannes Müller (Regiomontanus), the alleged years 1436-1476.

Copernicus, the alleged years 1473-1543. His book "On the Revolutions of the Celestial Spheres" was published in the alleged year of 1543, being the immediate heir of the scientific tradition of the Almagest, whose handwritten and printed copies become abundant in the epoch of Copernicus.

Tycho Brahe (1546-1601).

Purbach (Peuerbach), the alleged years 1423-1461.

Albrecht Dürer, the author of the star charts included in the first editions of the Almagest – the alleged years 1471-1528.

Ulugbek, the alleged years 1394-1449.

Kepler, 1571-1630.

Galileo, 1564-1642.

Edmond Halley, 1656-1742. Believed to have discovered proper star motions in 1718.

Johannes Hevelius, 1611-1687.

Roman emperor *Pius Augustus Maximilian I,* 1493-1519. His portrait is reproduced in fig. 11.13. Let us remind the reader that, according to the Scaligerian version, Ptolemy's Almagest was written in the reign of the "ancient" Roman emperor Antoninus Pius Augustus (the alleged years 138-161 A.D.).

Joseph Scaliger, the creator of the consensual

chronology of the antiquity, 1540-1609. His fundamental work on chronology was published in 1583 ([1387]).

Dionysius Petavius, Scaliger's follower – another author of the modern version of the ancient chronology (1583-1652). His oeuvres on chronology can be found in [1337] and [1338].

Johannes Gutenberg, the inventor of the printing press (circa the alleged year 1445 A.D.)

Let us conclude by going back to the problem of dating the Almagest manuscripts. We have already noted that their Scaligerian dating is based on palaeography for the most part. Even if we disregard the general vagueness of this method, it is compromised additionally by the known fact that the manufacture of handwritten book copies continued well into the printing epoch (the XV-XVIII century). It is also possible that some XVII-XIX patrons of the arts could specifically order the manufacture of manuscripts that would look "ancient" from the point of view of handwriting, artwork etc. A revision of datings ascribed to the surviving manuscripts of the Almagest would be extremely useful in this respect. The following issues would have to be addressed in the course of this work.

1) The location of the manuscript (archive, museum, private collection etc).

2) The history of the manuscript's discovery, the year it can be traced back to, the identity of the discoverer and the discovery circumstances (as well as the availability of documents describing the latter).

3) The dating of the manuscript. The identity of the party responsible for the very first dating, and their motivations. Is the dating in question unique and unambiguous? Are there other versions? In mathematical terms – how many solutions does the problem of a given manuscript's dating have?

4) Given that the author claims to have written the book in the reign of "Emperor Pius", it would be expedient to learn the exact identity of this Pius character. Is he likely to be identified as the famous Pius Augustus Maximilian, the Roman emperor of the XV-XVI century A.D.?

5) One must also bear in mind that most ancient names can be translated – Pius, for instance, stands for "pious" ([237], page 773), which means that the text in question was written in the reign of some emperor renowned for piety. It is obvious that the scribes could give such monikers to a great many different rulers of different lands. The lack of an unambiguous solution leads to a perfectly arbitrary choice of dating.

6) Sometimes we encounter considerations of the following type: "Such-and-such astronomer refers to Ptolemy; ergo, Ptolemy lived earlier than Such-and-such". This is a very controversial claim. First of all, we must find out which Ptolemy the astronomer in question referred to. Apart from that, the name "Ptolemy" can also be translated, which gives us even more options for identifying this character as an actual historical figure and more epochs to date his lifetime to.

7) Another postulation one often hears is as follows: "Such-and-such astronomer reports having read Ptolemy's Almagest; therefore, the Almagest was written before the epoch of this astronomer".

This conclusion is also ambiguous. It would make sense to enquire about the exact version of the Almagest referred to by this hypothetical astronomer. How does one prove that the text in question was the same that we know under the name of the Almagest today? After all, it is very possible that the ancient original was heavily edited in the early XVII century, say, and that the work that we know as the "Almagest" today differs a lot from what the astronomer in question read in the XV century, for instance.

Another question that one might ask is as follows: when did this hypothetical astronomer of ours actually live? Could it be the XVI-XVII century, and not the XV?

One mustn't regard any of the above as an extraneous cavil – on the contrary, the only way of providing the datings with a more or less reliable foundation is to answer each and every one of those questions. Otherwise, each date will do little more but reflect the subjective opinion of a single researcher. In general, it would be expedient to locate the original source of every Scaligerian dating and provide the "table of Scaligerian dates" with such commentaries as "the event in question took place in year X … according to such-and-such mediaeval chronologist". By naming the author of each and every "ancient" date in each and every case, we can finally reconstruct the original sources that the Scaligerian version relies on and make the dates available for objective verification.

5. SO WHAT IS THE ALMAGEST, ANYWAY?

It must be said that the name "Ptolemy's Almagest" is used for referring to a host of manuscripts and printed editions, some of which differ from each other quite substantially.

For example, some of the versions omit the star catalogue, or certain other parts of the Almagest (there are many examples of such discrepancies in [1339]).

The consensual opinion of today's scientists is that all these handwritten and printed versions can be traced back to a common "ancient original", which "was naturally lost" – and "a long time ago", at that.

However, the discrepancies between different versions (handwritten and printed) go far beyond the regular "scribe errata".

The text and the composition of the book can also differ from one another greatly.

We have discussed one of such cases at length above – there are substantial differences between the editions of 1537 and 1538. The longitudes of all the stars in the catalogue differ by 20 degrees, no less.

One gets the impression that "Ptolemy's Almagest" was the trademark name of all the oeuvres published by a whole school of mediaeval astronomers. Our idea is that the version of the Almagest that has reached us is not the original work of a single author, who is also to be credited with all the observations, but rather a collective "mediaeval astronomy textbook", containing a revision of results obtained from the research of a prominent mediaeval school of astronomy.

The authors and the editors of the Almagest may have gathered together a plethora of individual observation results, as well as theories, calculations and "chronological exercises", all of them contributed by different astronomers who might have been decades apart from one another chronologically. In particular, the Almagest star catalogue could have been compiled by a single observer in the epoch of the X-XIII century, whereas the final text of the Almagest was written and edited by other people in the XVI-XVII century.

6. ODDITIES IN THE DEVELOPMENT OF THE ASTRONOMICAL SCIENCE AS PORTRAYED IN THE "SCALIGERIAN TEXTBOOK"

6.1. The efflorescence of the so-called "ancient astronomy"

According to the history of astronomy in its Scaligerian version, many great astronomical discoveries were made by "the ancients". Let us name a few of them briefly. It is presumed that some textbook on navigational astronomy existed in the "ancient" Greece, which was compiled in the beginning of the alleged VI century B.C. – most probably, by Thales of Miletus, who lived in the alleged years 624-547 B.C. ([395], page 13). Already in the alleged IV century B.C. Theophrastus of Athens, an ancient Greek philosopher and natural scientist, observed solar spots ([395], page 14). Methon, born around the alleged year 460 B.C., made the discovery that 19 years are almost exactly equal to 235 lunar months. The discrepancy is indeed smaller than 24 hours. Almost a century later, Calippus introduced a minor correction into Methon's formula ([65], pages 34-35).

"There is a great shortage of definitive information concerning the life of Pythagoras. He was born in the beginning of the VI century B.C. and died at the end of the same century or the beginning of the next one" ([65], page 36). Pythagoras claimed that the Earth, likewise other celestial objects, had the shape of a sphere and was floating among other luminaries without any support. "Greek philosophers have remained convinced about the spherical shape of the Earth ever since Pythagoras" ([65], pages 36-37).

A detailed cosmology based on the Pythagorean concepts was devised by Philolaus, who lived in the alleged years 470-399 B.C. He opined that the centre of the world wasn't earthen, but rather had the nature of a central fire, and that the Earth, the Moon, the Sun, the planets and the celestial sphere revolved around it. The Earth was also said to revolve around its own axis apart from that in such a manner that no observer could see the central fire at any one moment ([395], page 23). "Philolaus claimed that the distances between the central fire and various celes-

tial bodies grew in geometric progression, each next luminary located at three times the distance between itself and the previous luminary. Had he claimed the distance to be double, not triple, he would have anticipated the rule of Titius-Bode by more than two thousand years" ([395], page 31).

Already in the alleged VI century B.C. Hycetes the Pythagorean voiced the idea that the earth, located at the centre of the world, makes a full revolution around its central axis over the course of a day. The philosopher Heraclides Ponticus, who lived in the alleged years 390-310 B.C., claimed that the planets Venus and Mercury revolved around the Sun and also around the Earth ([395], page 24). "Later authors name three other Pythagoreans who believed in the motion of the Earth – namely, Hycetes, Heraclitus and Ecthantes, who lived in the late VI and the V century B.C." ([65], page 38).

Democritus, who is believed to have lived in the alleged years 460-370 B.C., claimed that the Universe consisted of an infinite variety of worlds, which had come into existence as a result of collision between atoms. All these worlds had different sizes – some lacked the Moon and the Sun, others sported luminaries of a larger size, and others still would have a different number of luminaries. Certain worlds would have no water, animals, or plants. Some of the worlds would thus be nascent, others in their prime, and more still in the phase of destruction. "Democritus made a number of amazing guesses, which were confirmed centuries later. In particular, he claimed that the size of the Sun was several orders greater than that of the Earth, that the Moon shone with reflected sunlight and that the Milky Way was an agglomeration of a great many stars" ([395], page 25).

Plato, whose lifetime is dated to the alleged years 428-347 B.C., didn't write any oeuvres of a purely astronomical nature. In particular, he was of the opinion that the centre of the Universe was not the Earth, but rather a more perfect body ([65], page 38). In particular, Plato describes celestial bodies in the order of their remoteness. He believed this order to be as follows: the Moon, the Sun, Mercury, Venus, Mars, Jupiter, Saturn and the stars.

Eudoxes, Plato's apprentice who lived in the alleged years 408-355 B.C., "placed" the immobile Earth at the centre of the universe. Obviously, the Earth was considered spherical. Furthermore, he made the assumption that the motion of each planet was regulated by several concentric spheres ([395], page 27). A complex theory of these spheres was constructed as a result; in particular, Eudoxes aimed to explain the planetary declinations from the ecliptic and their retrograde motion. He managed to explain all visible planetary motion as caused by the rotation of 27 spheres.

Aristotle, who lived in the alleged years 384-322 B.C., claimed that the planets were further away from the Earth than the Sun and the Moon, and that the distance between the Earth and the celestial sphere was nine times greater than the distance between the Earth and the Sun at the very least" ([395], page 30). "Aristotle considered the issue of telluric and lunar shape in the most serious manner, approaching it from every possible angle. He used the above argumentation (concerning the phases of the Moon, the shape of the Earth's shadow etc) to prove both the Earth and the Moon to be spherical" ([395], page 30). Aristotle was familiar with the theories of other scientists about the Earth revolving around the Sun accompanied by other planets as opposed to the Earth being immobile and the Sun revolving around it. However, he came up with the following counter-argumentation. If the Earth were indeed mobile, this motion would cause regular changes of angular distances between two arbitrarily chosen pairs of stars, which wasn't observed by any astronomer known to him ([395], page 30). This consideration is perfectly valid, since it is associated with the real effect of parallax stellar motion. The ancient astronomers could not have observed it due to the extremely small shift rates. "The annual parallax motion of stars was discovered a whole 2150 years after Aristotle" ([395], page 30).

The astronomers of the Alexandria school mentioned most frequently are Aristarchus of Samos, Aristyllus and Timocharis – all of them near-contemporaries from the first half of the alleged III century B.C. ([65], page 44).

It turns out that "the ancients" had "a Copernicus of their very own" ([127]). This part was played by Aristarchus of Samos, who is presumed to have lived in 310-250 B.C. He was struck by the realisation that certain measurements and calculations made it possible to estimate the distances between the objects of

the Sun – Earth – Moon system. This theory was implemented in his oeuvre "On the Size and Distance of the Sun and the Moon". His basic postulations are as follows.

1) The Moon borrows its light from the Sun.

2) The Sun is the central point in relation to the lunar sphere.

3) When we see the Moon as divided in two, the larger circle that separates the light half from the dark half pertains to the plane that comprises our line of eyesight.

4) When we see the Moon as divided in two, its distance from the Sun is less than a quarter of the circumference with a thirtieth part of this circumference subtracted.

5) The width of the Earth's shadow covers two Moons.

6) The Moon occupies a fifteenth part of a given Zodiacal sign.

Apparently, "the oeuvre in question was the first work in the history of astronomy that estimated the distances between various celestial bodies as a result of observation. However, the actual results of these calculations left a lot to be desired in terms of precision" ([395], page 33). Nevertheless, "apparently, these calculations eventually led him to the conclusion that the Sun, being a large body, is located at the centre of the world, with the Earth and other planets revolving around it" ([395], page 33).

This is what Archimedes, who lived in the alleged years 287-212 B.C., wrote about this heliocentric cosmology: "Aristarchus of Samos … comes to the conclusion that the size of the world is much greater than it has been stated above. He opines that the immobile stars and the Sun do not alter their positions in space, that the Earth moves around the Sun in a circular trajectory, and that the centre of the stellar sphere coincides with that of the Sun, whereas its size is so great that the circumference he believes to be the trajectory of the Earth is in the same proportion to the distance of the immobile stars as the centre of the sphere is to its surface" ([395], page 34).

This viewpoint is virtually identical to Copernican – in reality, what we hear is the voice of the scientists who lived in the XVI-XVII century A.D. Furthermore, it is believed that the "ancient" Aristarchus was aware of the true value of the Moon's angular diameter.

Aristotle had conducted measurements of the Earth as a sphere. The size of the Earth was subsequently calculated with greater precision by Eratosthenes, who lived in the alleged years 276-194 B.C. It is believed that the error made by Eratosthenes equalled a mere 1.3%. Another assumption is that Eratosthenes had calculated the angle between the ecliptic and the equator, which he claimed to equal 23° 51'. It is noteworthy that Ptolemy's Almagest refers to this very value (see Chapter 8 of the present book). As we have already pointed out, this value of the ecliptic declination angle permits a more precise estimation of the possible Almagest compilation date.

S. V. Zhitomirskiy performed a reconstruction of the cosmological model devised by the "ancient" Archimedes in [280], using the numeric data provided by the latter as the basis. According to I. A. Klimishin, "the reader is confronted by an elegant geo/heliocentric cosmological model where Mercury, Venus and Mars revolve around the Sun, which accompanies them in their rotation around the Earth, likewise Jupiter and Saturn. The relative radius values of Mercury, Venus and Mars are in good enough correspondence with their true values" ([395], page 38). Archimedes created an "autonomously mobile instrument" – the mechanical "celestial globe" used for demonstrating the visibility conditions of the luminaries as well as solar and lunar eclipses. All this research is most likely to date from the XV-XVI century in reality, transposed into ages immemorial by Scaligerian chronology.

The "ancient" Cicero pointed out that "the solid sphere without cavities was invented a long time ago; the first such sphere was made by Thales of Miletus, and the next one – by Eudoxus of Cnidus, named as Plato's apprentice, who drew the celestial positions of the stars and constellations upon it … Many years later, Aratus … wrote verses about the construction of this sphere and the position of the luminaries upon it, which he had borrowed from Eudoxus … The invention of Archimedes is amazing by the very fact that he devised a method of preserving the heterogeneous trajectories of different motions resulting from a single revolution. Whenever Gallus would set this bronze sphere in motion, the Moon changed positions with the Sun for as many times as it did in the sky, which would lead to similar eclipses taking place

in the sky of the sphere, with the Moon obscured by the shadow of the Earth" ([948], page 14).

A similar cosmosphere is said to have been constructed by Posidonius, already after Archimedes. According to Cicero, "if somebody took the sphere (sphaera) that our friend Posidonius has made recently to Scythia or Britain, with its individual rotations reproducing the motions of the Sun, the Moon and the five planets on different days and nights, would any denizen of these barbaric countries doubt this sphere to be a creation of the perfect mind?" ([951], page 129).

One cannot help recollecting the epoch of the XVI-XVII century, when Tycho Brahe was one of the first to construct the famous cosmosphere, which his contemporaries believed to be a miracle of science and art. Therefore, the "ancient" Cicero is most likely to have written his oeuvres in the XV-XVII century A.D., describing the spectacular achievements of his contemporaries.

Nowadays it is believed that one of the greatest merits of Greek astronomy was the development of a mathematical point of view on celestial phenomena. The spheres of rotation were introduced, as well as related elements of spherical geometry and trigonometry etc. "Several minor tractates and reference books have survived until our day, written during the Alexandrian period for the most part and concerned with the above mentioned scientific discipline (known as spherics, or the science of the spheres); an excellent example of such an oeuvre is the "Phaenomena" of the famous geometrician Euclid (circa 300 B.C.)" ([65], page 46). Apollonius of Perga, who lived in the second part of the III century B.C., is to be credited with the discovery that the motions of the celestial objects can be represented by a combination of even circular motions with much greater ease than the rotating spheres of Eudoxus and his school could ever allow ([65], page 49).

The consensual opinion is that the "ancient" astronomy started to transform into a natural science owing to the labours of Hipparchus, whose lifetime is dated to the alleged years 185-125 B.C. "Hipparchus was the first one to conduct systematic astronomical observations and perform an exhaustive mathematical analysis of the resulting data. He has developed the theory of solar and lunar motion as well as the method of forecasting eclipses with the tolerance margin of 1-2 hours, also laying down the foundations of spherical astronomy and trigonometry" ([395], page 43). Hipparchus has introduced the distinction between the stellar year and the tropical year, and discovered the phenomenon of precession – the motion of the spring equinox point towards the Sun along the ecliptic. 169 years before Hipparchus, the astronomers Aristyllus and Timocharis recorded the positions of 18 stars. Hipparchus used their data in order to calculate the precession effect ([395], pages 43-44). Hipparchus has also compiled a star catalogue containing 850 items, indicating the ecliptic coordinates and the magnitude of every star. According to the consensual opinion of our days, "the constellations mentioned by Hipparchus are virtually identical to the constellations of Eudoxus; their list has undergone very few changes to date, if we don't take into account a certain number of new constellations from the Southern Hemisphere, unknown to the civilised nations of the ancient world" ([65], page 56).

Jean-Baptiste Delambre (1749-1822), a French scholar of the history of astronomy, wrote the following about Hipparchus in his "Histoire de l'Astronomie Ancienne": "Once you consider everything that was invented or perfected by Hipparchus and ponder the sheer number of his works and the volume of calculations they contain, you cannot help calling him one of the most amazing men of the ancient times and the greatest of them all" ([65], page 63). However, our primary source of information about the works of Hipparchus is Ptolemy's Almagest. The only surviving work of Hipparchus is the commentary to the poem of Aratus and its source (the work of Eudoxus).

The achievements of the "ancient" astronomers are believed to have been repeated after many centuries of stagnation and decline by the mediaeval astronomers of the Renaissance epoch. The level of astronomical knowledge in the "ancient" society was so high that it became reflected in a variety of aspects wholly unrelated to science. For instance, some of the "ancient" military tribunes in the regular Roman army were capable of reading bona fide scientific lectures to their troops on the theory of lunar eclipses. This is what we learn from the eminent "ancient" historian Titus Livy. The fifth decade of his "History of

Rome" contains an amazingly precise description of a lunar eclipse. "Caius Sulpicius Gallus, the military tribune of the second legion … gathered his troops by leave of the consul and declared that the Moon would disappear from the sky between the second and the fourth hour of the night to follow, and that nobody should take it as an omen … This … is a normal occurrence, which conforms to laws of nature and takes place in its due time. After all, it surprises no one that the Moon is a radiant disc on some nights and a thin crescent as it wanes, since the luminaries rise and set in a regular manner. The fact that the Moon gets obscured by the shadow of the Earth should not be considered a miracle, either. When the eclipse did come to pass that night, on the eve of the September nonnae, the very hour that was named …" ([482], XLIV, 37; also [483], pages 513-514).

Today we are told that this involved lecture, which we have reproduced only partially, was read to the iron legions of the "ancient" Rome about 2000 years before our day and age (see Ginzel's [1154], pages 190-191, No 27). Anyone familiar with the history of science is greatly impressed by this "lecture for the ancient soldiers" – even greater so considering the next time interval, namely, the mediaeval period between the alleged II century A.D. and the X century A.D. in Scaligerian history of astronomy.

6.2. The beginning of the mysterious "decline of the ancient astronomy" in Scaligerian history

And so, Scaligerian history claims the "ancient" astronomy to have reached an unprecedented period of efflorescence. However, it is believed to be followed by "the three centuries that passed after the death of Hipparchus, when the history of astronomy seems to have been shrouded by utter darkness" ([65], page 63). Presumably, this was the beginning of the great stagnation epoch, known for nothing but the propagation and popularisation of the great discoveries made by Hipparchus ([65], page 64). Virtually the only conspicuous peak of the next three centuries in the "darkening" history of Greek astronomy is Ptolemy's Almagest, regarded as "the final chord of the ancient astronomy". It is followed by a period of great darkness and taciturnity in Scaligerian history of astronomy. According to A. Berry, "the last great name that we encounter in Greek astronomy is that of Claudius Ptolemy" ([65], page 64). It is assumed that Ptolemy was born in Egypt. His observations were conducted in Alexandria in the alleged years 127-141 A.D. His death is dated to the alleged year 168 A.D. ([65]).

6.3. The alleged millenarian "return to infancy" and the primitive character of mediaeval astronomy

It would be most edifying to contrast the above brilliant scientific lecture of an "ancient" military tribune read to the Roman legionaries by a voyage to the alleged VI century A.D. for the sake of hearing the cosmological explanation of the famed Cosmas Indicopleustes, a recognized authority in mediaeval cosmography. He made a special study of the Sun, the Moon and the stars in the alleged VI century A.D.

Cosmas Indicopleustes is of the opinion that the Universe is constructed like a primitive box. This famous ancient drawing of the world is reproduced in "The History of Cartography" ([1177], page 262). In fig. 11.16 we see a drawn copy thereof (the original is reproduced further, in fig. 11.40). What do we see? Inside the box there is a flat Earth washed by the Ocean, with a gigantic mountain reaching for the sky. The celestial dome is supported by the four walls of the Universal box. The Sun and the Moon hide behind this mountain for a certain part of the day. The lid of the box is decorated with tiny stellar nails. This viewpoint, expressed by a "renowned professional", reflects the whole set of the rudimentary and therefore very primitive cosmological concepts of the antiquity – most likely, the X-XIII century.

The oeuvre of Cosmas Indicopleustes entitled "Christian Topography", which includes the above cosmological model, was created around 535 A.D., as it is believed today. It was extremely popular in the Christian world. Modern commentators suggest the following explanation of this phenomenon: "If we take a closer look at it [the work of Cosmas], we might just discover that the immense popularity of the 'Christian Topography' had nothing to do with the cosmological ideas expressed in this book, and simply reflected the appetite of the mediaeval reader … for the colourful miniatures that adorn the oldest copies of the tractate in question" ([395], page 77).

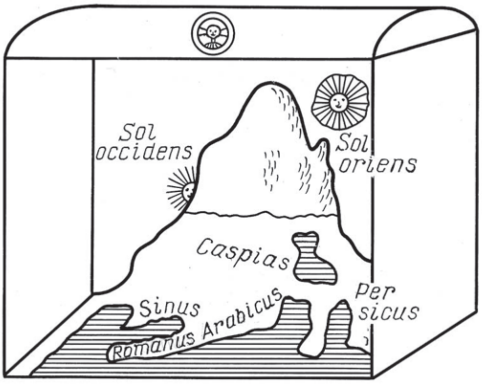


Fig. 11.16. A drawn copy of the "World Map" by Cosmas Indicopleustes. The oldest map can be found in the ***History of Cartography***, for instance ([1777], page 262). We shall reproduce it below, in fig. 11.40.

This "explanation" is hardly acceptable. In reality, the map, as well as the entire work of Indicopleustes, must have been created in the XIII-XIV century A.D. the very earliest (see CHRON1 for more details). This book reflected the concepts of its epoch, and was at some point considered a great advance of scientific thought, hence its popularity.

Anyway, what dire fate could have befallen the ancient cosmological concepts, if we are to believe Scaligerian history? How did the human understanding of astronomy plummet to the Stone Age level of the alleged VI century A.D.? Or is it just the ignorance of Cosmas Indicopleustes, his reputation of a prominent scientist notwithstanding? Apparently, this isn't the case – we are presented with a general picture of the "mediaeval darkness". Let us quote from certain specialists in history of astronomy. This is what they write about this period: "The decline of the ancient culture. The amazing efflorescence of the ancient culture on the European continent was followed by a lengthy period of certain stagnation (and, in some cases, degradation), spanning over 1000 years and commonly referred to as the Middle Ages … No astronomical discoveries of any importance were made by anyone during this period" ([395], page 73). The consensual explanation of this phenomenon (which strikes us as rather constricted) is as follows: mediaeval Christianity was incompatible with science.

According to A. Berry, "the history of Greek astronomy de facto ends with Ptolemy. The art of observation degraded to such an extent that there were hardly any observations of any scientific value performed over the 8.5 centuries that separate Ptolemy from Albatenius … The handful of Greek writers that emerged after Ptolemy comprised compilers and collectors in the vein of Theon (365 A.D.) at best; not one of them can be credited with so much as a single original or valuable thought" ([65], page 72).

All the scholars who specialise in the history of sciences are obliged to conform to Scaligerian chronology, which is why they write such passages about the mediaeval "relapse of infancy" as this one: "Figuratively speaking, the conception of a flat Earth can be dated to the epoch of humankind's infancy … We have already seen how the Greek philosophers managed to come up with scientific proof of the spherical shape of the Earth, calculate its size and estimate the distance to the Sun and the Moon … But we see new generations of people gripped by religious fanaticism … They destroy every achievement of their predecessors. Everywhere we see … relapses of infancy afflicting human ideas of the world around them. In particular, we see the "resurrection" of the flat earth conception – many centuries will pass before it is vanquished once again (in the XI century, no less)" ([395], pages 74-75).

A. Berry comments the Scaligerian history of astronomy as follows: "Some fourteen centuries have passed between the publication of the Almagest and the death of Copernicus (1541) … This period … has not yielded a single solitary astronomical discovery of any importance … The theory of astronomy hardly managed to make any advances at all – in some respects, it simply degraded, since the popular doctrines, some of them even more correct than Ptolemy's, were approached with infinitely less understanding in this epoch, and nowhere near as conscientiously as in the antiquity. As we have already seen, no remarkable discoveries were made in the first five centuries after Ptolemy. Next we have an almost total blank, with hundreds of years to pass until the interest in astronomy is revived" ([65], page 75).

A. Berry sums up as follows: "Inasmuch as Europe is concerned, the Dark Ages that followed the decline of the Roman Empire [in the alleged VI century A.D. – Auth.] … strike one as a blank spot in the history

of astronomy, as well as pretty much any other natural science" ([65], page 81).

Our idea is very simple. These "blank spots", "gaps", "centuries of utter silence", "global catastrophes" etc are nothing but a product of the erroneous Scaligerian chronology followed by the researchers of the history of science. As we have come to realise, this chronology contains "ancient" phantom reflections, or duplicates, as well as their consequences, such as the "Dark Ages" between the "antiquity" and the "Renaissance". Our new amended chronology eliminates all such oddities, lacunae and sinusoidal curves from the history of science and culture.

6.4. The astronomical boom of the Renaissance: original, not repetition

6.4.1. The astronomical "renaissance" of the Arabs

According to the European historical science, one must make many allowances to consider the scientific movement of the Islamic countries a true resurrection of the "ancient" ideas. This is what A. Berry points out in his review: "We cannot credit any of these astronomers, be they Arabic or not [the names of all the astronomers in question shall be cited below – Auth.], with a single original idea of any significance. Nevertheless, all of them possessed the remarkable ability to digest other people's ideas and develop them further to a certain extent, even if they didn't go all that far. They were all patient and accurate observers and skilful calculators. We owe them a great many observations, as well as inventions and important improvements of mathematical methods" ([65], page 80). The astronomical "renaissance" of the Arabs looks more like the actual nascence of astronomy as a science. This is confirmed by "a great many observations", which always serve as a foundation of an exact science. Let us cite relevant chronological data concerning the key figures of the Arabic astronomical renaissance.

The consensual opinion of our age is that "the first translation of the Almagest was ordered by Almansor's successor, Haroun al-Rashid (765 or 766-809), known as a character of the famed 'Arabian Nights'. This task must have been truly formidable: a new attempt to translate Ptolemy's work was made by Ghoneyn Ben-Isaac (? – 873) and his son Isaac Ben-Ghoneyn (? – 910 or 911), and the final version, established by Sabit Ibn-Korra (836-901) appeared by the end of the IX century … These endeavours of the Arabs have preserved many Greek works for us, whose originals perished" ([65], pages 76-77). As a matter of fact, the original of the Almagest is considered lost as well.

The Damascus Observatory was built during the period when the Caliphs resided in that city. Another observatory was built in Baghdad by Caliph Al-Mamoun in the alleged year 829 A.D. "Al-Mamoun ordered his astronomers to verify the Ptolemaic estimate of the size of the earth. Two independent measurements of a meridian's fragment were made as a result – however, they are so close to one another, and also to the erroneous result of Ptolemy, that they can hardly be perceived as accurate and wholly independent; one might rather consider them a rough verification of Ptolemaic calculations" ([65], page 77).

On the other hand, this opinion is contradicted by the following claim: "The precision of observations received so much attention that, according to some reports, the most interesting ones were registered in formal documents sealed by a united oath of several astronomers and lawyers" ([65], page 77).

In the second half of the alleged IX century, Ahmed Al-Fargani (Alfarganus, the author of the "Elements of Astrology") and Sabit Ibn-Korra worked in Baghdad. It is rather remarkable that this is the very time when the publication of astronomical tables commences. The tables were "based on pretty much the same principles as the Almagest" ([65], page 77). Sabit Ibn-Corra "has the dubious honour of being the discoverer of the hypothetical precession variation … Striving to explain it, he invented a complex mechanism … introducing … an arbitrary complication … which would plague the majority of astronomical tables that came out in the five or six centuries to follow with obscurity and confusion" ([65], page 77).

Al-Battani (Albatenius) is considered a much better qualified astronomer. His observations were conducted in the alleged years 878-918; he died in 929. "The last Baghdad astronomer was Abul-Wafah (allegedly 939 or 940-998), the author of a voluminous astronomical tractate, which was just as famous as the Almagest [sic! – Auth.]; it contained brilliant ideas, and its structure differed from Ptolemy's book, al-

though it was often confused for a translation of the latter [sic! – Auth.]" ([65], page 78).

Could the origins of the Almagest be traced to the works of Abul-Wafah, by any chance? Ibn-Younis was a near-contemporary of Abul-Wafah (? – 1008, or allegedly 950-1009) ([395], page 83). He is the author of the astronomical and mathematical tables (the so-called "Hakemite Tables"), which "would serve as specimens for two more centuries" ([65], page 78).

The "Book of Immobile Stars" by the astronomer Al-Sufi (Abd ar-Rakhman as-Sufi, allegedly 903-986 A.D.), is regarded as an outstanding achievement if the mediaeval observational astronomy. Incidentally, the name "Al-Sufi" translates as "Wise One" ([395], page 80). Let us once again state that most ancient and mediaeval names are translatable. The book was lavishly illustrated and contained a star catalogue. It is presumed that Al-Sufi "verified and corrected Ptolemy's star catalogue" ([395], page 80).

Abu Raikhan Birouni (allegedly 973-1048) conducted independent astronomical observations, calculating the declination angle between the ecliptic and the equator and coming up with the value of 23° 33' 45". He is credited with the construction of "possibly the very first" ([395], page 83) terrestrial globe (or, rather, half-globe) 5 metres in diameter. In the alleged years 1031-1037 Birouni creates his "Masoud Canon" – an encyclopaedia of astronomy. He indicates a slightly different value of angle ε – 23° 34' 0". The true value for his epoch equals 23° 34' 45". He also includes a catalogue of 1029 stars with their coordinates and stellar magnitudes as per Ptolemy and Al-Sufi ([395], page 84). "In general, the 'Masoud Canon' is modelled after the same pattern as the Almagest, in a somewhat geocentric spirit" ([395], page 84).

In the alleged X-XII century A.D. great advances were made by the astronomers working in the Islamic part of Spain. Al-Zarqali, also known as Arzachel, lived in the alleged years 1029-1198. He improved the construction of the astrolabe and published a volume of astronomical tables in the alleged year 1080 (the so-called "Toledo tables"). Individual astronomical issues were also studied by Mohammed Ibn-Rushd, alias Averroes (the alleged years 1126-1198), Moses Ben-Maymon, or Maymonide (allegedly 1135-1204), Al-Bitrujji (died around 1204), who is supposed to have "revived" some of the ideas ascribed to Eudoxus ([395], page 86).

According to the conclusion of A. Berry, "we owe certain improvements in instrument construction and observation methods to this school; it has published several works with a critique of Ptolemy – however, without any corrections of his ideas. About this time, the Christian Spaniards started to drive their Mohammedan neighbours out. Cordoba was captured in 1236, and Seville – in 1248; their fall heralded the historical demise of Arabic astronomy" ([65], page 79).

The next hotbed of astronomical science is associated with the reign of Hulegu-Khan, the grandson of Genghis-Khan. In the alleged year 1258 he conquered Baghdad. Several years earlier, the astronomer Nasir Al-Din Tusi (allegedly 1201-1274, born in Tusa, Khorasan) became his advisor. Tusi founded a large astronomical centre and an observatory in the city of Maragha (nowadays part of Iranian Azerbaijan). "The instruments they used were large and very sturdy in construction – most probably superior in quality to any of the instruments used in Europe in the epoch of Copernicus; the first European instruments to excel them were those of Tycho Brahe" ([65], page 79). The astronomers of this group compiled a number of astronomical tables, based on the Hakemite Tables of Ibn-Yunis and known as the Ilkhan Tables. They comprised the tables for the calculation of planetary positions and a star catalogue, "which was based on new observations to a certain extent" ([65], page 80).

It is believed that Samarqand became a prominent astronomical centre during the forty-year reign of Ulugbek (Ulug-Begh), the grandson of Tamerlane (allegedly 1394-1449). A large observatory was built here in the alleged year 1424. Ulugbek "published the new planetary tables; however, his main body of work had been a star catalogue that included virtually the same stars as Ptolemy's catalogue, but with amended coordinates based on newer observations. This was most probably the first completely autonomous catalogue since Hipparchus. The positions of the stars are exceptionally precise; they indicate minutes as well as degrees … Although there are discrepancies of several minutes between this catalogue and the results of modern observations, one must think that the instruments used by Ulugbek were very good indeed … Tartar astronomy ceased to exist after his death" ([65], page 80).

If we forget the Scaligerian version for a few mo-

ments (which claims all the research conducted by the Arabic astronomers to be of secondary nature as compared to the past glories of the "ancient" astronomy), we must admit that the Arabs put forth some new and deep ideas. In this case, the sceptical opinion of A. Berry, which we quoted at the beginning of this section, shall be supported by nothing but Scaligerian chronology, which dates the advances of the "ancient" astronomy to imaginary epochs supposed to precede the Arabic astronomical "renaissance" by many centuries.

6.4.2. The astronomical "renaissance" in Europe

"In the X century, the excellent reputation of Arabic science gradually reached different parts of Europe by proxy of Spain" ([65], page 81). Herbert, the famous scientist who was also a pope (Sylvester II, in the alleged years of 999-1003), had a particular interest in mathematics and astronomy. "Many other scientists were just as interested in Arabic science, but it was only a century later that the influence of the Mohammedans became obvious" ([65], page 82).

Already in the XI century A.D., the Byzantines Michael Psellus (allegedly 1018-1097) and Simeon Seth "revive" and cite numerous (and presumably familiar to everyone since Aristotle, if we are to believe Scaligerian chronology) demonstrations of the Earth's spherical shape, discuss the length of the telluric circumference, the relations between the radiuses of the Sun, the Earth and the Moon etc. See [395], page 78.

"Italy has played a major role in rousing Europe from millenarian slumber" ([395], page 92). It is believed that Latin translations of scientific and philosophical tractates from Arabic originals appeared in the early XII century. Plato of Tivoli translated the "Astronomy" of Albatenius in the alleged year 1116. Then Adelard of Bath translated Euclid's "Elements". After than, Gerard of Cremona (allegedly 1114-1187) translated the Almagest and Arzachel's Toledo Tables ([65], page 82). There is a surge of interest in the works of Aristotle. "European scientists become interested in his works in the XI-XII century; by the XII-XIII century, Aristotle's influence over the mediaeval thought becomes almost overwhelming – many scholastics were just as awed by his works as they were by the works of the most prominent Christian theologians, if not more" ([65], page 82).

Western Europe develops an even greater familiarity with the Arabic astronomy under Alfonso X, King of Leon and Castile (allegedly 1223-1284). He acts as the leader of a group of scientists that compiles a series of new astronomical tables – the so-called "Alfonsine tables", which came to replace the Toledo tables. The Alfonsine tables were published in 1252 and quickly became popular everywhere in Europe. The modern opinion is that they "didn't contain any novel ideas; however, many of the numeric data, especially the length of a year, were estimated with greater precision than before" ([65], page 82).

The book entitled "Libros de Saber" was compiled under Alfonso – a voluminous encyclopaedia summarising the astronomical knowledge of that epoch. Even though it was derived from Arabic sources to a large extent, "it is by no means a mere collection of translations, as some had thought. This book contains a curious diagram of Mercury's orbit, which has the shape of an ellipsis [sic! – Auth.] with the Earth at its centre … This must have been the very dawn of the conception of using non-circular curves for the motions of celestial objects" ([65], pages 82-83). The Alfonsine tables "were used in every European country for 200 years" ([395], page 93).

The English astronomer John Halifax of Holywood, who lived in the alleged years 1200-1256, is known better under the Latinised alias of Sacrobosco. His tractate entitled "Sphaera Mundi" (The Universal Sphere) "enjoyed great popularity for three or four centuries; there were many re-editions, translations and commentaries; it was one of the first books on astronomy ever printed. 25 editions of this book came out between 1472 and the end of the XV century, and 40 more were published in the middle of the XVII century" ([65], page 83).

Nevertheless, the erroneous Scaligerian chronology, which shifts the advances of the "ancient" and Arabic astronomers to epochs that predate the XI-XII century A.D. leads modern researchers to the conclusion that the scientists of the X-XIII century A.D. "contented themselves with collecting and systematising whatever astronomical knowledge they could borrow from the Arabs and the Greeks; we neither see any serious attempts of developing the theory, nor any observations of importance" ([65], page 83).

Jean Buridan, a prominent French scientist (al-

legedly 1300-1358), is known as the author of a book about the structure of the Universe. In particular, he has conducted an in-depth research of the issue of "whether the Earth was always in a state of calm at the centre of the Universe". His follower Nicholas d'Oresme (allegedly 1323-1382) published "The Book of the Heavens and the Universe", wherein he voiced his support of the hypothesis of daily Earth rotation. Nicholas of Cusa (allegedly 1401-1464), claimed that the Earth could not be the centre of the Universe. He is the author of the tractate entitled "On Learned Ignorance" ([395], pages 96-97).

According to the official version, it was only in the XV century A.D. that "a new school emerged in Germany, contributing to the accumulated body of scientific knowledge, although in no crucial way; it was very independent, and heralded the beginning of a whole new scientific research" ([65], page 83).

Georg Purbach (allegedly 1423-1461) wrote "The Concise Astronomy", presumably based on the Almagest. However, it is believed that he used low quality Latin translations of the Almagest, "packed with errata" ([65], page 84). Purbach's activities were carried on by Johannes or Wolfgang Müller ([395], page 94), alias Regiomontanus (allegedly 1436-1476). Both astronomers (Regiomontanus was Purbach's apprentice) conducted a vast amount of observations ([65], page 84).

It is believed that Purbach was "the first West European to have encapsulated Ptolemy's theory together with the cosmology of Aristotle" ([395], page 94). However, this book of Purbach (the "New Planetary Theory") was only published by Regiomontanus in 1472, already after Purbach's death. After that, Regiomontanus published Purbach's "Concise Astronomy" – in 1472 or 1473, using his own printing press (already in Nuremberg, qv in [65], page 85). It is believed that after the death of Purbach in the alleged year 1461 Regiomontanus went to Italy, where he "got the opportunity" to read the Almagest in Greek ([65], page 84). In 1468 he returned to Vienna with a number of Greek manuscripts, and then moved to Nuremberg, where he got a grandiose reception. Bernhard Walther (allegedly 1430-1504), a wealthy citizen, provided him with lavish funds and became the apprentice and collaborator of Regiomontanus, in spite of his being much older than the latter.

"The most skilled craftsmen of Nuremberg were busy constructing astronomical instruments with precision previously unheard of in Europe, although they must have been worse than the instruments of Nasir-Eddin and Ulugbek" [which have not survived, and were presumably manufactured several centuries earlier – Auth.] ([65], page 85). After the death of Regiomontanus in the alleged year 1476, "Walther continued with the research commenced by his friend and conducted a series of good observations; he was the first [sic! – Auth.] one who tried to compensate the effect of atmospheric refraction, which Ptolemy must have pictured very vaguely indeed" ([65], page 87). Today it is believed that "Walther constructed an armilla, using the Ptolemaic description of the instrument as a guideline; he used it to measure the positions of planets with the precision margin of 5' (1' in case of the Sun) – substantially more precise than Ptolemy's observations" ([395], page 95).

It is presumed that the astronomical instruments that were allegedly used "since Ptolemy" began to propagate all across Europe in this very epoch. Leonardo Da Vinci (allegedly 1452-1519) "was the first to explain the dim glow of the moon's dark part, when the sunlit part is in the phase of a crescent ([65], page 87). This phenomenon is known as "ash glow" or "ash light". Gerome Fracastor (allegedly 1483-1543) and Petrus Apianus (allegedly 1495-1552) were the first ones to note that a comet's tail always faces away from the Sun. They are the authors of famous books on astronomy. Peter Nonius (allegedly 1492-1577) offered correct solutions to problems concerning the duration of the nighttime. "A new measurement of the Earth's size, first since Caliph Al-Mamoun, was made around 1528 by Dr. Jean Fernel (1497-1558)" ([65], pages 87-88).

We have reached Copernicus in our motion forward along the time axis. A. Berry sums up the historical period in question in the following words: "The life of Regiomontanus overlaps the first three years of Copernicus's lifetime … we can therefore say that we have reached the end of the stagnation period described in the present chapter" ([65], page 88). I. A. Klimishin also notes: "this is how the astronomical observations and cosmological research recommenced in Europe after a millenarian interruption" ([395]). In general, Edmond Whitaker, the English mathemati-

cian and astronomer (1873-1956) was correct to point out the following: "In 1500 Europeans knew less then Archimedes, who died in 212 B.C." ([395], page 98).

6.4.3. The boom of European astronomy in the XV-XVI century

Nicolaus Copernicus (allegedly 1473-1543) is the author of the heliocentric cosmology. It is customary to place him at the very beginning of the European astronomy's independent and rapid efflorescence ([65]). In Chapter 1 we have already pointed out the continuity of ideas and "astronomic observations separated by an interval of almost 2000 years; when Copernicus considers the issue of precession, he cites the observation data of his faraway predecessors" ([395], page 109). Copernicus refers to Timocharis, Hipparchus, Menelaus, Ptolemy, Albatenius etc. One must strive for absolute certainty in the issue whether the work of Copernicus that has reached our epoch could be edited radically in the late XVI or early XVII century.

It is assumed that the theory of Copernicus was carried further and popularized by Rheticus, or Georg Joachim, born in the alleged year 1514. The next prominent astronomer, who was quick in taking to the new ideas, was his comrade Erasmus Reinhold (1511-1553) ([65], pages 114-115). He used the Copernican theory for calculations necessary to compile tables of celestial objects' motions. He published them, and they became very popular under the moniker of "Prussian tables". These turned out much better than the Alfonsine tables, and remained in use for a quarter of a century, to be outshone by the Rudolfine tables of Kepler eventually.

In 1561 Wilhelm IV of Hessen-Kassel (1532-1592) builds the Kassel Observatory, where he begins to compile a catalogue of stars with Christian Rothman and Jost Bürgi, young and very apt astronomers (see Chapter 1; also [65], pages 117-118). By 1586, the positions of 121 stars were measured with the utmost precision. This is when the activities of Tycho Brahe attain supreme renown (see Chapter 1 for more on his works). "Over the 21 years that Tycho spent on the Isle of Guene, a wealth of outstanding observations was accumulated by the astronomer himself as well as his apprentices and assistants. The precision of these observations excelled all the achievements of his predecessors. He also paid a sufficient deal of attention to alchemy and medicine to some extent" ([65], page 123).

The further development of astronomy becomes so rapid that our brief overview can by no means highlight every primary trend in this science. At any rate, this is quite beyond the scope of the present book. We shall therefore simply provide a brief list of certain most prominent scientists and their achievements. Our attention should gradually turn towards the large chronological table that the following section deals with.

Giordano Bruno (real name Philip; 1548-1600) insisted that eternity was infinite and that the worlds were multiple. He is the author of a number of books on philosophy, which de facto develop the ideas of Copernicus.

Galileo Galilei (1564-1642) – a famous astronomer and the author of several spectacular astronomical discoveries: the first telescopic observations in history of astronomy, the satellites of Jupiter, phases of Venus etc. He was an active proponent of the Copernican system.

Johannes Kepler (1571-1630) – an apprentice of Tycho Brahe. He has discovered the fundamental laws that planetary motion conforms to.

"The first measurement of the Earth, which was performed in the XVII century, must be regarded as a definite step forward as compared to the measurements of the Greeks and Arabs" ([65], page 178). These measurements are associated with the names of the following astronomers: Villebrord Snellius (1591-1626), Richard Norwood (1590?-1675), Jean Picard (1620-1682) and Andrian Osu (?-1691).

We shall end our list here and move on to our next idea, which gives one a very tangible idea of how astronomy and cosmological conceptions are believed to have evolved in Scaligerian chronology.

6.5. Bottom-line chronological diagram which demonstrates oddities inherent in the development of the astronomical science in the consensual chronological paradigm of Scaliger and Petavius

Let us consider the epoch between the X century B.C. and the present, attempting to picture the qualitative development of the astronomical science in

Scaligerian dates. Biographical dates shall comprise the "visual material" for the scientists who bore some relation to astronomical issues in one historical epoch or another. Each of the scientists shall be represented by a corresponding horizontal fragment on the diagram, whose beginning and end shall correspond to the dates of the scientist's birth and death. The density of these fragments shall be a very edifying representation of how intensely the astronomical science developed around the epoch in question. This method is arbitrary to some extent, yet has a number of tangible benefits. The matter is that each such name is associated with actual astronomical information in the history of sciences, and we can trace its evolution by the diagram. It goes without saying that the quantity of astronomers per epoch is a very approximate pointer. And yet it reflects the intensity of scientific development to some extent.

We are confronted by the next issue – namely, one of compiling a list of astronomers to encompass the period between "the Scaligerian antiquity" and the present days. We can by no means claim the ability to create an exhaustive list – none such is likely to exist in the modern astronomical literature, either, or the publications on the history of astronomy, for that matter. This is why we have opted for the following approach. We took the following three monographs: "The Crime of Claudius Ptolemy" by Robert Newton ([614]), "Concise History of Astronomy" by A. Berry ([65]) and "The Discovery of the Universe" by I. A. Klimishin ([395]). Apart from its research of the Almagest, Robert Newton's book contains an excellent overview of the "ancient" and partially mediaeval astronomy's achievements. The books of A. Berry and I. A. Klimishin describe the history of astronomy between the "antiquity" and the present epoch. These monographs are focussed on the following three categories of historical figures for the most part.

1) Astronomers, professional scientists, observers etc.

2) Philosophers, writers and thinkers who discussed astronomical observations, phenomena and theories. When the authors' names are unknown, we cite the names of their tractates.

3) Commentators of astronomical works and translators of astronomical books. Let us also mark the foundations of the main observatories.

We have concentrated out attention on these three categories of characters and events, and copied each name pertaining to one of them from [614], [395] and [65] – each and every name, no less! We have estimated Scaligerian biographical dates of all these characters – for the most part, they are indicated in the books in question. Whenever the chronological data related to some astronomer are omitted, we turn to the modern encyclopaedic editions.

The book of R. Newton ([614]) has been processed in its entirety. As for A. Berry's book ([65]), only pages 17-244 have been analysed, with the modern period omitted. We have treated I. A. Klimishin's book ([395]) similarly, omitting the modern period and only considering pages 5-189. In other words, we have gathered all the information that interested us from the "antiquity" to the XVIII century A.D. inclusively. The number of astronomers has been growing rapidly ever since the end of the XVIII century, and we have omitted the statistical data of this period.

It is obvious enough that R. Newton, A. Berry and I. A. Klimishin by no means claim their books to contain an exhaustive list of names pertinent to the three categories mentioned above. However, it is nonetheless obvious that these authors have tried to reflect the history of the astronomical science's development in as many aspects as they could. The selection that they have conducted can be regarded as the effect of the mechanism of the "ordering and obliteration of information". First of all, the most famous names are mentioned, followed by a selection of the more obscure ones. Some astronomers are altogether omitted – one must assume that the history of science knows next to nothing about these characters, or, alternatively, that the author of the review does not consider them worthy of a mention for one reason or another. Without delving into the intricacies of this mechanism's functionality, we might assume it to be more or less objective in reflecting the evolution of information, where large data arrays are involved. It models the same obliteration of names that automatically happens in the history of a given science over the course of time (its justification is an altogether separate issue). Some names are forgotten for one reason or another; others have been preserved in memory.

We have deliberately chosen three books instead of limiting ourselves by just one. We have tried to es-

chew the influence of subjective motives affecting the selection of information sources. If one author "forgot" some famous name for some reason, there is the possibility that it will be mentioned by another author, and that the name of the prominent scientist will end up as part of our list.

One can learn more about the laws affecting the evolution and obliteration of written information from CHRON1, for instance.

Let us cite the full list of name constructed in the manner described above. The names were numbered 1-220. In other words, the three monographs ([614], [395] and [65]) contain 220 names of characters pertaining to one of the above three categories.

The resulting list of names isn't arranged all too precisely insofar as the Scaligerian scale is concerned. However, we have tried to arrange them by birth date in every known case, without aiming for absolute orderliness, which is of no vital importance presently. It turns out that the multitude of names naturally falls apart into several groups, which do not intersect between themselves, in correspondence to various geographic regions. Our list is therefore divided into the following categories: 37 names for the "ancient" Greece, 2 names for China, 1 name for Babylon, 15 names for Rome (Europe between the II century B.C. and 700 A.D.), 1 name for India, 6 names for Byzantium, 26 names for Islamic countries and 112 names for Europe between 700 A.D. and the XVIII century A.D.

Apart from the names, the list accounts for corresponding lifetime dates or events. In some cases, Scaligerian dates are only known approximately – as the century, for instance, or as the annals registering a certain action of a given historical figure in a certain year. Due to insufficient space, we do not estimate the motives guiding A. Berry, R. Newton and I. A. Klimishin when they mentioned one character or another in their monographs.

THE "ANCIENT" GREECE.

1. Homer, allegedly around VIII century B.C.
2. Hesiod, allegedly 725 – circa 650 B.C.
3. Numa, allegedly circa 716 – circa 673 B.C., Rome, the beginning of the regal period.
4. Thales of Miletus, allegedly 624-547 B.C. The theory of a round Earth.
5. Anaximander, allegedly 610-546 B.C.
6. Solon, allegedly circa 594 B.C.
7. Anaximenes, allegedly circa 585 – circa 525 B.C.
8. Pythagoras, allegedly circa 580 – circa 500 B.C.
9. Heraclitus of Ephesus, allegedly circa 544 – circa 470 B.C.
10. Hecateus (Hicetius) of Miletus (Syracuse), allegedly the end of VI – V century B.C. Round Earth theory.
11. Ecphantus, allegedly end VI – V century B.C.
12. Anaxagoras, allegedly circa 500 – circa 428 B.C.
13. Empedocles, allegedly circa 490-430 B.C.
14. Philolaus, allegedly circa 470-399 B.C.
15. Meton, allegedly circa 460-? B.C.
16. Democritus, allegedly circa 460-370 B.C.
17. Euctemon, allegedly circa 432 B.C.
18. Plato, allegedly 427-347 B.C.
19. Eudoxus of Cnidus, allegedly circa 408-355 B.C.
20. Theophrastus of Athens, allegedly circa IV century B.C.
21. Heraclides Ponticus, allegedly circa 390-310 B.C.
22. Pitheus, allegedly circa IV century B.C.
23. Aristotle, allegedly 384-322 B.C.
24. Calippus, allegedly circa 370-300 B.C.
25. Epicurus, allegedly 341-270 B.C.
26. Aristarchus of Samos, allegedly circa 410-255 B.C.
27. Aristyllus, allegedly circa IV – III century B.C.
28. Timocharis, allegedly circa IV – III century B.C.
29. Diogenes Laertius, allegedly circa 1 half of III century B.C.
30. Euclid, allegedly circa III century B.C.
31. Aratus, allegedly circa III century B.C.
32. Archimedes, allegedly circa 287 – circa 212 B.C.
33. Eratosthenes, allegedly circa 276 – circa 194 or 196 B.C.
34. Dionysius, allegedly circa 264 B.C.
35. Apollonius of Perga, allegedly circa 262-200 B.C.
36. Hipparchus, allegedly circa 185-125 B.C.
37. Seleucus (of Seleucia), allegedly the middle of the II century B.C.

CHINA.

38. Chu Kong, allegedly circa 1100 B.C.
39. Shi Sheng, allegedly circa IV century B.C.

BABYLON.

40. Beros, allegedly circa 280 B.C.

ROME AND EUROPE BETWEEN II CENTURY B.C. AND 700 A.D.

41. Posidonius, allegedly circa 100 – circa 50 B.C.
42. Geminus, allegedly circa 100 B.C.
43. Cicero, allegedly 106-43 B.C.
44. Titus Lucretius Carus, allegedly 99-55 B.C.
45. Sosigenes (Alexandria) and Julius Caesar, allegedly first half of I century B.C.
46. Virgil, allegedly 70-19 B.C.
47. Titus Livy, allegedly 59 B.C. – 17 A.D.
48. Ovid, allegedly 43 B.C. – 17 A.D.
49. Eratosthenes II. Historians distinguish him from Eratosthenes I, Alexandria, allegedly the second half of I century A.D.
50. Conon of Samos (Alexandria), allegedly the second half of I century B.C.
51. Seneca, allegedly 3 B.C. – 65 A.D.
52. Pliny the Elder, allegedly 23-79 or 24-79 A.D.
53. Plutarch, allegedly 46-126 A.D.
54. Galen, allegedly circa II century A.D.
55. Menelaus, allegedly circa 98-100 A.D.
56. Theon, allegedly circa I-II century A.D.
57. Ptolemy (Alexandria), ? – allegedly circa 168 A.D. It is suggested to date his observations to circa 127-141 A.D.
58. Abideen, allegedly circa II century A.D.
59. Sextus Empiricus, allegedly circa II-III century A.D.
60. Origen, allegedly 185-254 A.D.
61. Hippolytus, bishop, allegedly 1st half of III century A.D.
62. Censorinus, allegedly circa 238 A.D.
63. Lucius Caelius Firmianus (Lactantius), writer and theologian, allegedly circa 250-320 A.D.
64. Pappus, mathematician, allegedly circa 300 A.D.
65. Theon of Alexandria, allegedly circa IV century A.D.
66. Basil the Great, Bishop of Caesarea, allegedly circa 330-379 A.D.
67. John Chrysostom, allegedly circa 347 – circa 407 A.D.
68. St. Augustine, allegedly circa 354-430 A.D.
69. Proclus, allegedly circa V century A.D.
70. Marcian Felix Cappella (of Carthage), allegedly circa V century A.D.
71. Macrobius, allegedly circa V century A.D.
72. Simplicius of Athens, allegedly circa V century A.D.
73. Heliodorus, allegedly circa 509 A.D.
74. Cosmas Indicopleustes, Alexandrian monk, allegedly circa 535 A.D.
75. Isidore, Bishop of Seville, allegedly circa 600 A.D.

INDIA.

76. Ariabhata, allegedly circa 476 A.D.

BYZANTIUM.

77. John Damascene, allegedly circa 680-760 A.D.
78. Leo Mathematicus, allegedly circa 805-870 A.D.
79. Patriarch Photios, allegedly circa 820-891 A.D.
80. Suidas or Suda – Byzantine encyclopaedia (Lexicon Suidas), allegedly circa 1000 A.D.
81. Simeon Seth, allegedly circa XI century A.D.
82. Michael Psellus, 1018 – circa 1097 A.D.

ISLAMIC COUNTRIES.

83. Ibn-Yusuf, allegedly 786-833 A.D.
84. Al-Khabash Al-Khaseeb, Baghdad, allegedly circa first half of the IX century A.D.
85. Muhammad Ibn-Mussa Al-Khoresmi, Baghdad, allegedly circa 783 – circa 847 A.D.
86. Sabit Ibn-Korra, allegedly 836-901 A.D.
87. Ghoneyn Ben-Isaac, ? – allegedly 873 A.D.
88. Al-Mamoun, allegedly circa IX century A.D.
89. Ahmed Al-Fargani (Alfraganus), Baghdad, allegedly second half of IX century A.D.
90. Abu Abdallah Muhammad Ibn-Jabir Al-Battani (Albatenius), Baghdad, allegedly 850-929 A.D.
91. Issaac Ben-Ghoneyn, ? – allegedly 910 or 911 A.D.
92. Abd Al-Rahman Al-Sufi, Baghdad, allegedly 903-986 A.D.
93. Abu Al-Wafa Al-Buzjani, or Abul Wafa, allegedly 940-998 A.D.
94. Ibn-Yunis (the publisher of the Hakemite tables), allegedly 950-1008 or 1009 A.D.
95. Ibn-Iraq, allegedly circa 961-1036 A.D.
96. Abu-Sahl Al-Kuhi, Baghdad, allegedly circa 990 A.D.

97. Abu-Raikhan Birouni (Berouni), allegedly 973-1048 A.D.

98. Abu-Mahmoud Al-Hujandi, ? – allegedly circa 1000 A.D.

99. Abu Said Al-Sijizi, allegedly first half of the XI century A.D.

100. Al-Zarqali (Arzachel), Mohammedan Spain. Toledo tables, allegedly 1029-1087 A.D.

101. Mohammed Ibn-Rushd (Averroes), allegedly 1126-1198 A.D.

102. Moshe Ben Maimon (Maimonides), Jewish scientist, allegedly 1135-1204 A.D.

103. Al-Bitruji, Moroccan astronomer, ? – allegedly 1204 A.D.

104. Nasireddin Al-Tusi (Iranian Azerbaijan), allegedly 1201-1274 A.D.

105. Ibn Al-Shatir, allegedly 1304-1376 A.D.

106. Kazy-Zade Al-Rumi (Samarqand), allegedly circa 1412 A.D.

107. Ulugbek (Ulug-Begh, Samarqand), allegedly 1394-1449 A.D.

108. Abd Al-Ali Al-Kushchi (Samarqand), ? – allegedly 1474 A.D.

EUROPE FROM 700 A.D. TO THE XVIII CENTURY.

109. Alcuin (at the court of Charlemagne), allegedly 735-804 A.D.

110. Syncellus, allegedly circa 800 A.D.

111. Herbert, Pope Sylvester II, allegedly between 999 and 1003 A.D.

112. Plato of Tivoli, translator, allegedly circa 1116 A.D.

113. Gerhard of Cremona, translator, allegedly 1114-1187 A.D.

114. Albertus Magnus, allegedly circa 1193-1280 A.D.

115. Cecco D'Ascoli, allegedly circa XIII century A.D.

116. John of Holywood (alias Halifax, or Sacrobosco) – allegedly 1200-1256 A.D.

117. Roger Bacon, allegedly circa 1214-1294 A.D.

118. Alfonso X and the compilation of the Alfonsine tables in 1252 – allegedly 1226 or 1223-1284 A.D.

119. Thomas Aquinas, allegedly 1225-1274 A.D.

120. Dante Alighieri, allegedly 1265-1321 A.D.

121. Jean Buridan, allegedly 1300-1358 A.D.

122. Nicolas Oresme, allegedly 1323-1382 A.D.

123. Levi Ben-Gerson, allegedly circa 1325 A.D. We shall be omitting the "A.D." part as self-implied henceforth.

124. Nicolaus Cusanus, allegedly 1401-1464.

125. Georg Purbach, allegedly 1423-1461.

126. Bernhard Walther, allegedly 1430-1504.

127. Wolfgang (Johannes) Müller (Regiomontanus), allegedly 1436-1476.

128. Wojciech Brudzewski, allegedly 1445-1497.

129. Domenico Novara, allegedly 1452-1504.

130. Leonardo Da Vinci, allegedly 1452-1519.

131. Albrecht Dürer, allegedly 1471-1528, the author of the Almagest star charts (1515).

132. Nicolaus Copernicus, allegedly 1473-1543.

133. Gerome Fracastor, allegedly 1483-1543.

134. Petrus Apianus, allegedly 1495-1552.

135. Petrus Nonius, allegedly 1492-1577.

136. Jean Fernel, allegedly 1497-1558.

137. Robert Recorde, allegedly 1510-1558.

138. Georg Joachim von Lauchen, alias Rheticus, allegedly 1514-1576.

139. Erasmus Reinhold and the Prussian tables, allegedly 1511-1553.

140. Wilhelm IV of Hessen-Kassel, allegedly 1532-1592.

141. William Gilbert, allegedly 1544-1603.

142. Thomas Digges, allegedly 1546-1595.

143. Simon Stevin, allegedly 1548-1620.

144. Leonard Digges, ? – allegedly 1571.

145. Porta, allegedly circa 1558.

146. Joseph Scaliger, 1540-1609. He is the author of the consensual chronology of the antiquity (assisted by his helpers and apprentices). Their primary works on chronology were published in the late XVI – early XVII century. The more or less reliable datings come into existence as late as the XVII century (post-dating Scaliger and Petavius).

147. Joost Bürgi, 1552-1632.

148. Piccolomini, allegedly circa 1559.

149. Tycho Brahe, 1546-1601.

150. Giordano (Philip) Bruno, 1548-1600.

151. Reimarus Ursus (Nicolaus Reimers Bär), ? – 1600.

152. Hans Lippershey, ? – 1619.

153. Johannes Kepler, 1571-1630.

154. Galileo Galilei, 1564-1642.

155. Christoph Scheiner, 1575-1650.

156. Johann Bayer, 1572-1625.
157. Simon Marius, 1570-1624.
158. Willebrord Snellius, 1580-1626.
159. Dionysius Petavius, 1583-1652. Apprentice of Scaliger, author of the chronology of the antiquity.
160. Thomas Harriot, 1560-1621.
161. Rene Descartes, 1596-1650.
162. Richard Norwood, 1590-1675.
163. Giovanni Battista Riccioli, 1598-1671.
164. Michel Florent Van Langren, 1600-1675.
165. Johannes Fabricius, 1587-1615.
166. Christian Rothman, circa 1577.
167. Michael Maestlin, circa 1589.
168. William Gascoigne, circa 1612-1644.
169. Francesco Maria Grimaldi, 1618-1663.
170. Johannes Hevelius, 1611-1687.
171. Jean Picard, 1620-1682.
172. Evangelista Torricelli, 1608-1647.
173. Bonaventura Cavalieri, 1598-1647.
174. Ismaël Boulliau, 1605-1694.
175. Giovanni Alfonso Borelli, 1608-1679.
176. John Wilkins, 1614-1672.
177. Stanislaw Lubieniecki, 1623-1675.
178. Robert Hooke, 1635-1703.
179. Christiaan Huygens, 1629-1695.
180. Giovanni Domenico Cassini, 1625-1712.
181. Rudolfine tables, 1627.
182. James Gregory, 1638-1675.
183. John Flamsteed, 1646-1720.
184. Abraham Sharp, 1651-1742.
185. Ole Rømer, 1644-1710.
186. Gottfried Wilhelm Leibnitz, 1646-1716.
187. Sir Isaac Newton, 1643-1727.
188. Bernard le Bovier de Fontenelle, 1657-1757.
189. Jacques Cassini, 1677-1756.
190. The construction of the Paris Observatory, 1667.
191. The construction of the Greenwich Observatory, 1675.
192. Samuel Molyneux, 1689-1728.
193. Jean Richet, ? – 1696
194. Edmond Halley, 1656-1742. Believed to have discovered the phenomenon of proper star motion in 1718.
195. James Bradley, 1693-1762.
196. Colin MacLaurin, 1698-1746.
197. Nathaniel Bliss, 1700-1764.
198. Pierre Bouger, 1698-1758.
199. Charles Marie de la Condamine, 1701-1774.
200. Louis Godin, 1704-1760.
201. Pierre Louis Moreau de Maupertuis, 1698-1759.
202. Leonhard Euler, 1707-1783.
203. Józef Aleksander Jablonowski, 1711-1777.
204. Joseph Crosthwaite, circa 1700.
205. Pehr Wilhelm Wargentin, 1717-1783.
206. John Michell, 1724-1793.
207. Nevil Maskelyme, 1732-1811.
208. Charles Hutton, 1737-1823.
209. Henry Cavendish, 1731-1810.
210. Charles Mason, 1730-1787.
211. César François Cassini de Thury, 1714-1787.
212. Tobias Mayer, 1723-1762.
213. Nicolas Louis de Lacaille, 1713-1763.
214. Pierre-Simon Laplace, 1749-1827.
215. Jean-Baptiste Delambre (specialist in the history of astronomy), 1749-1822.
216. Grigoriy Arakelovich, 1732-1798.
217. Joseph-Louis Lagrange, 1736-1813.
218. John Machin, ?-1751.
219. Jens Swanberg, 1771-1851.
220. Johann Franz Encke, 1791-1865.

We decided to cut the list here. Joseph Scaliger and Dionysius Petavius (see #146 and #159), aren't mentioned anywhere in books [614], [395] or [65]; nevertheless, we include them in the list, since their activities were directly associated with astronomy. They used the descriptions of astronomical events in dating.

We have drawn all the dates from the list in figs. 11.17, 11.18 and 11.19. The numeration in the illustrations corresponds to the numbers in the list. Due to insufficient space in the drawings, only some of the numbers are annotated. All the "ancient" names are stated, as well as the most famous mediaeval names.

What can one say after a study of the resulting diagram? Lots of interesting details, as it turns out.

Firstly, Scaligerian history clearly contains a strange mediaeval "regress period" in the history of Rome's and Europe's astronomical development. This lapse even affects the quantity of historical characters bearing some relation to astronomy at least in one way or another. We are not even mentioning the "low level"

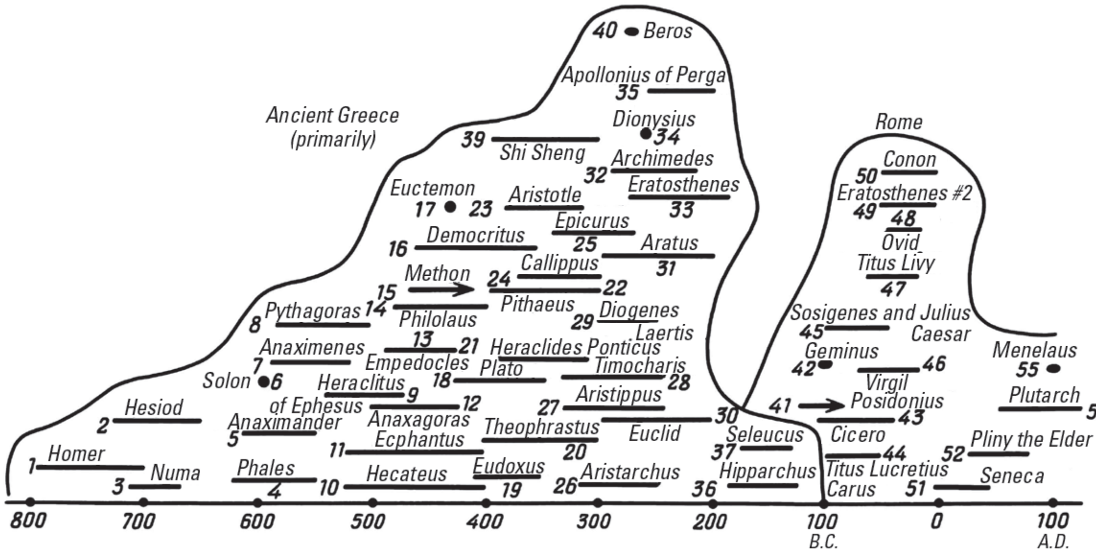


Fig. 11.17. Chronological graph that demonstrates the lifetimes of the "ancient" and mediaeval figures who bore relation to astronomy in one way or another along the time axis. The datings are given according to the Scaligerian chronology. One sees a manifest peak in the "ancient" Greece followed by a strange drop to near-zero.

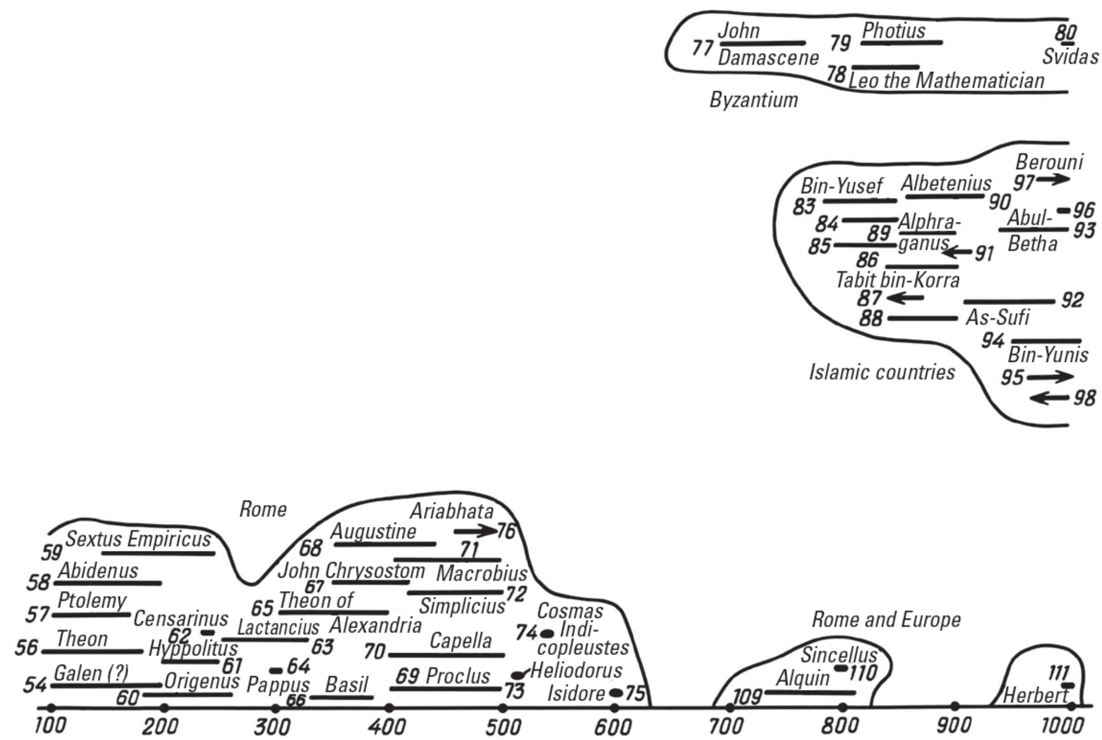


Fig. 11.18. Chronological graph continued. One sees a manifest peak in the "ancient" Rome, followed by a near-total drop.

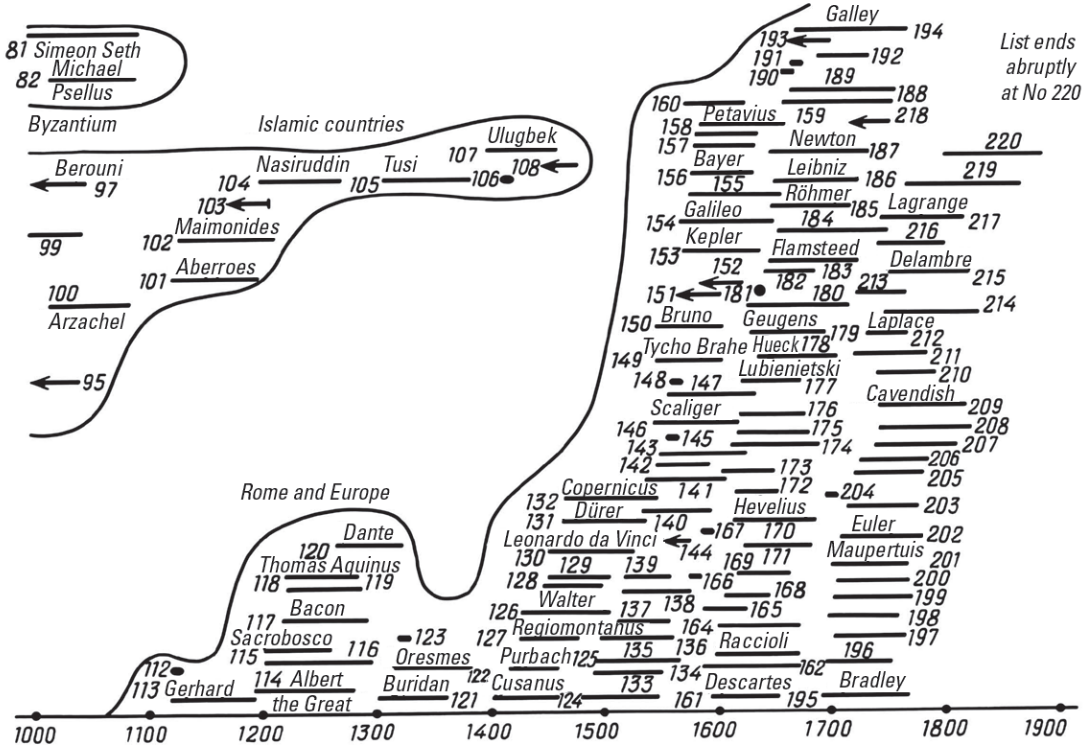


Fig. 11.19. Chronological graph continued. According to Scaligerian history, the European "astronomical Renaissance" began in the XI century A.D., after several centuries of presumed decline and stagnation.

of astronomical concepts prevalent during this "period of decline" – see more on this topic above.

Secondly, a more or less stable growth only begins in the alleged year 1100 A.D.

Thirdly, it is obvious that the "Byzantine part" of the resulting diagram is rigidly localised in time, as well as the part corresponding to the Islamic countries. The Byzantine "renaissance" begins in the alleged VII century A.D. and ends in the alleged XI century A.D. The "Arabic surge" begins in the alleged VIII century A.D. and ends in the alleged XII century A.D. The per century density of Byzantine astronomers falls drastically right then.

In order to get a more demonstrable picture of these effects, let us construct the following density graph. We must count the astronomers with lifetimes pertaining to every century, partially or wholly, keeping in mind that a single character can become split between two adjacent centuries as a result. The graphs constructed on the basis of the above data can be seen in figs. 11.20 and 11.21. The uninterrupted line is the density graph built for the astronomers of the Islamic countries in fig, 11.20, while the dotted line represents Byzantium. You can clearly see the allegedly local character of these two brief surges of astronomical science. The peak of the "Arabic astronomical renaissance" falls over the IX-XI century A.D., as we have noted above.

In fig. 11.21 we see the resulting density graph of astronomers of Greece, Rome and Europe. The "antiquity" is obviously very prominent. We see a massive peak on the left of the graph. Then we see an amazing "mediaeval regress". The "decline lacuna" between the alleged VII and XI century A.D. is the most obvious.

Only starting with the XIII-XIV century A.D. do we see a rapid and even growth – which is manifest on the graph as well, from 1300 A.D. and up until our

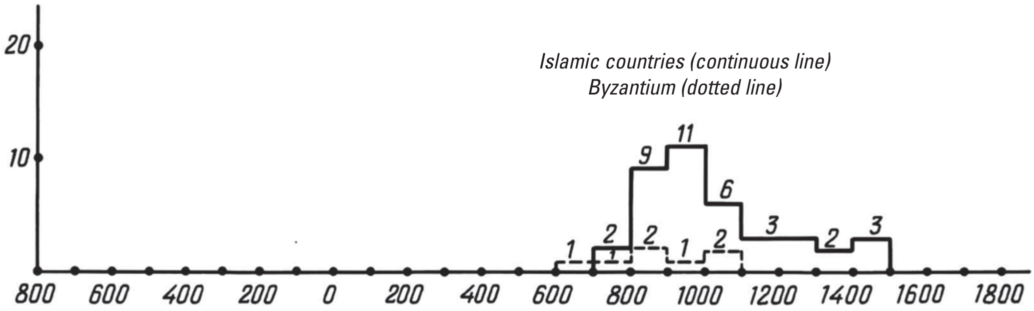


Fig. 11.20. Islamic and Byzantine astronomers as distributed across the "Scaligerian time axis".

day and age. No strange "declines" or secondary "surges", and no "sine curves", either.

We discover good concurrence between the end result and our corollaries, which were based on altogether different methods, qv in Chron1 and Chron2. We discover it time and again that the correct chronology begins around the XIII-XIV century A.D. Events dated to epochs earlier than XI century A.D. today are phantoms, which goes to say that they reflect real but much more recent (mediaeval) events. Duplicates of XIII-XIV century events were misdated to distant past, which has spawned all those "grandiose ancient surges" in astronomy, art, military science and culture in general interspersed by "glum centuries of decline".

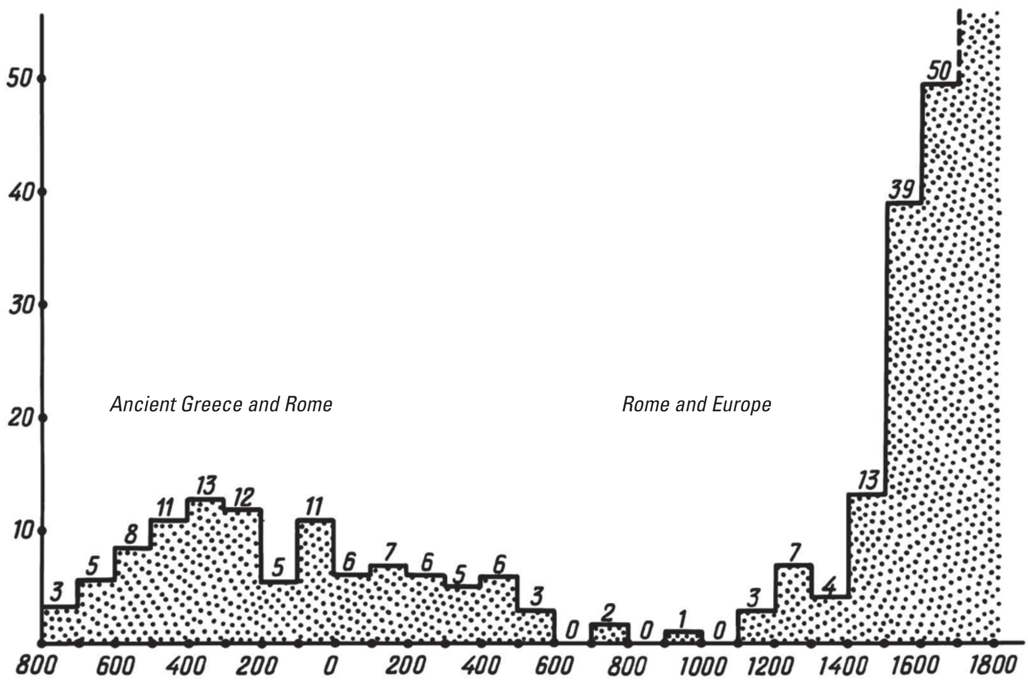


Fig. 11.21. A generalised graph that reflects the "evolution of astronomy" according to the Scaligerian chronology. The "ancient" peak is perfectly obvious, as well as the ensuing "dark ages of stagnation". It is just starting with the XIII-XIV century A.D. that we see astronomy to develop rapidly and evenly, with no drastic peaks.

6.6. Corollaries

1) Scaligerian history of astronomy tells us of a rather odd event – an intense "build-up" of the "ancient" astronomy followed by millenarian decline, then another surge and steady growth ever since the XIII century A.D.

2) Scaligerian history tries to convince us that nearly all the primary accomplishments of mediaeval astronomy of the XIV-XVI century A.D. were "already discovered" more than 1000 years earlier, in the so-called "ancient" period, and then mysteriously forgotten for many centuries.

3) Let us list some primary astronomical ideas, allegedly discovered by the "ancient" astronomers ages ago and then "rediscovered" in the XI-XVII century A.D. after many years of oblivion.

a) Ecliptic and equatorial coordinates, conversion methods.

b) Estimation of the primary elements of the theory of planetary motion for Solar System.

c) The heliocentric planetary system theory.

d) The estimation of distances in the Sun – Earth – Moon – planets – stars system.

e) Prediction of lunar eclipses.

f) Compilation of star catalogues.

g) Construction of cosmospheres.

h) The discovery of precession.

i) Professional astronomical instruments: the astrolabe etc.

j) The calculation of the sidereal year and the calculation of the equinoctial year.

k) The definition of constellations and the fixation of their "patterns".

l) The issue of proper star motion.

We leave aside the fact that, according to Scaligerite historians, in the "ancient" China of the alleged year 1100 B.C. (a great deal earlier than the "ancient astronomical boom" in Greece) Chu Kong, a Chinese astronomer, measured the length of the gnomon shadow during the summer and winter solstice, estimating the angle between the ecliptic and the equinoctial with the flabbergasting precision of 23° 54' 02" ([395], page 8). As we are beginning to understand, the event in question is a phantom reflection of some real astronomical experiment that took place in the epoch of the XVI-XVII century.

Without insisting on any finite conclusion, we cannot help noticing that the above facts strike one as very odd indeed. One must however be aware that all such oddities owe their existence to the Scaligerian version of history. Once it is abandoned, with all the chronological shifts taken into account, we be left with a perfectly natural and comprehensible picture of astronomy's development, from the XIII-XIV century A.D. onwards. The astronomical discoveries as listed above appear to have been made in the epoch of the XII-XVII century, with their duplicates cast deep into the past by the erroneous Scaligerian chronology. In reality, there were no substantial "regresses" in the history of science and culture.

7. COPERNICUS, TYCHO BRAHE AND KEPLER. THE RELATION BETWEEN JOHANNES KEPLER AND THE FINAL VERSION OF THE COPERNICAN OEUVRE

7.1. What we know about Copernicus and his astronomical endeavours. Was the heliocentric cosmological system indeed discovered in the first half of the XVI century and not any later?

Copernicus is believed to have lived in the XV-XVI century, in 1473-1543 ([395], page 99). It is further believed that the dates of Tycho Brahe's life are 1546-1601, whereas Kepler, Brahe's apprentice, lived in 1571-1630. That is, according to Scaligerian history, these astronomers constitute the following sequence: Copernicus, Brahe and Kepler.

In figs. 11.22 and 11.23 we reproduce two ancient portraits of Copernicus, known to us today as a great astronomer. It is difficult to say whether the portraits depict the same person or not. Incidentally, the first one portrays Copernicus as a doctor – not an astronomer! According to the specialists in the history of sciences, "one of the portraits depicts Copernicus holding a lily-of-the-valley – an emblem of the medical profession" ([44], pages 80-81). Another version of the portrait also depicts Copernicus holding a lily of the valley – a doctor yet again, qv in fig. 11.24. There are, of course, portraits of Copernicus that emphasise his astronomical affiliation – all of them of a more recent origin than the old portrait in fig. 11.22.

Fig. 11.22. Ancient portrait of Copernicus holding a lily of the valley. This is how one drew doctors, not astronomers. The original portrait is kept in the Copernicus Museum, Frauenburg. Taken from [44], inset between pages 12 and 13.

Fig. 11.23. Ancient portrait of Copernicus. The original is kept in the National Library, Paris. Taken from [44], inset between pages 160 and 161.

However, even this portrait must have been created relatively recently.

Specialists in the history of sciences have noted this somewhat strange fact a long time ago. Having pondered it, they suggested the following explanation: "the Aesculapian art of Copernicus was valued so high that the artist must have received recommendations to portray the venerable canon and learned astronomer holding a lily-of-the-valley" ([44], page 81). This might be true – however, we haven't managed to find any ancient portraits of such famous astronomers as Claudius Ptolemy, Tycho Brahe or Johannes Kepler with symbols referring to some other profession. After all, despite Tycho Brahe's famous passion for the manufacture of instruments and globes, nobody drew him apron-clad and wielding a lathe tool. There aren't any portraits of Kepler with a brush and a palette, either. Ptolemy was also portrayed as an astronomer exclusively in all the ancient sources (see fig. 12.25). Therefore, the case of Copernicus is strangely conspicuous if we regard the mediaeval astronomers en masse.

Could this mean that in the XV-XVI century the primary occupation of Copernicus was actually medicine? His active interest in astronomy may have been ascribed to him much later, in the XVII century, during the construction of the "XVI century history of astronomical sciences", likewise one of the greatest astronomical discoveries.

There is some reason to enquire about this. Indeed, let us point out the following circumstance, which is

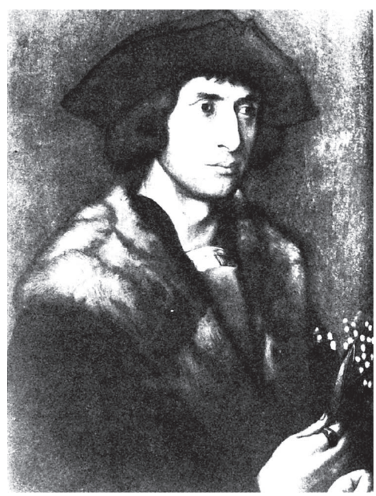


Fig. 11.24. Copernicus holding a lily of the valley in his hands – a symbol of the guild of medics. Taken from [926], page 54.

Fig. 11.25. Ancient drawing of Ptolemy accompanied by Astronomia and Urania. An engraving from a Venetian edition of Sacrobosco's ***Universal Sphere***, allegedly dated to 1490. Taken from [98], page 42.

of great importance. Apparently, "unfortunately, his [Copernicus's – Auth.] oldest biographies already date from the XVII century; we shall mention two of their lot – the book of Simon Starowolski and that of Pierre Gassendi" ([44], page 8). See also Gassendi's book ([1152]). This means that the first biographies of Copernicus were written in the epoch of Johannes Kepler the earliest. Moreover, "even the year of his birth remains dubious to date. Most biographers accept 19 February (old style) 1473 as the most likely date. It is based on the testimony of Michael Maestlin, Kepler's teacher" ([44], page 8).

However, a more in-depth acquaintance with "Maestlin's testimony" reveals the following circumstance, which is rather odd. Apparently, "Maestlin reports that Copernicus was born on 19 February 1473, at 4:48 PM" ([44], page 8). It has to be borne in mind that the minute hand did not yet exist on XV century clocks. Modern biographers of Copernicus usually modestly omit the "precise birth date", in full awareness that "4:48 PM" is a fancy of Maestlin. Nevertheless, it is presumed that he did know the exact date. We doubt this – after all, it is reported that the first biographies of Copernicus were created in the XVII century and not any earlier – therefore, fantasy is very likely to be their primary element (or, alternatively, the astronomical calculations of the XVII century when the "precise birth date" of the great Copernicus could be "calculated backwards from the positions of the stars". Bear in mind that Johannes Kepler was a "very prolific and enthusiastic astrologist, who had studied under Maestlin" ([926], [395] and [44]).

Let us mark the fact that the first "biographies of Copernicus" were written by none other than Kepler's teacher.

One must admit that some of the modern specialists in the history of science are well aware of the vagueness of "Maestlin's testimony", likewise other reports made by the first biographers of Copernicus in the XVII century. It is honestly stated that "we know nothing about the great astronomer's childhood – no verbal information from that epoch of his life has survived anywhere" ([44], page 8). Therefore, inspired references to "4:48 PM" are obviously a literary fantasy of literary-minded scientists of Kepler's epoch, or manifestations of astrological cabbalism characteristic for the very same epoch of the XVII century.

Specialists in the history of science report that the main "visible" activities of Copernicus were those of a doctor, canon and administrator. These three words constitute the name of one of the book's chapters ([44], page 39). There is no mention of astronomy. It is pointed out that "Copernicus was de facto performing a bishop's duties … remaining in charge of the parish for half a year" ([44], page 76). Moreover, "in 1520 Copernicus finds himself governor of Holstein, where he has to solve the problem of protecting the city from the raids of the militant Teutonic Order" ([926], page 56).

Nowadays we are told that Copernicus was an undercover astronomer who never advertised so much as his astronomical inclinations, let alone his great dis-

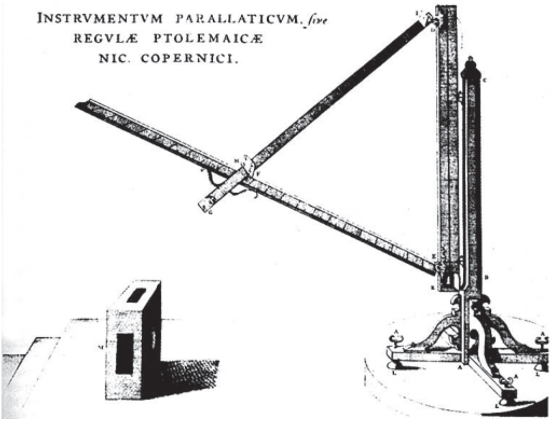


Fig. 11.26. "Triquetrum – the instrument that Nicholas Copernicus had used for observations" ([926], page 55). Made of fir wood. The authors are trying to convince us that Copernicus had made his great astronomical discovery with the aid of this primitive wooden instrument. Taken from [926], page 55.

Fig. 11.27. An old portrait of the "ancient" Ptolemy, who is holding a wooden instrument in his hand. We recognize the instrument as identical to the Copernican "triquetrum". Taken from [98], page 8. Another version of the same engraving (the "second original"?) was already cited above, in fig. 0.1.

covery. This is what we learn: "He kept his manuscript secret from everyone … Copernicus never shared his plans with anyone; his work was wholly undercover, and even his uncle knew nothing of the revolution in astronomy prepared by his genius nephew" ([44], pages 41-42).

The preparation of the book of Copernicus is described as follows today: "Already by 1509 Copernicus was known as a bold reformer of astronomy, albeit to a rather limited group of people. Few must have been aware of him – one must think that nobody suspected the existence of a voluminous tractate authored by Copernicus and already finished as a draft by that time" ([44], page 47).

Let us agree with the Scaligerite biographers of Copernicus for a moment and assume that his astronomical activities remained secretive all his life for one reason or another. Apparently, any astronomer of this calibre, someone who made a discovery this great, must have carried on his observations for many a year. One must ask the following question: what instruments did he use? For instance, Ptolemy describes a variety of astronomical instruments in the Almagest at a great length – all of them complex and rather expensive. Tycho Brahe had a passion for creating unique new astronomical devices, and launched a whole industry of professional craftsmen (quite impossible without state support due to its sheer price). One would assume that Copernicus did something similar. However, Scaligerian history tells us different, painting a rather odd picture in this case as well.

We quote: "Large-scale calculations were required, which would invariably have to be based on a certain amount of new observations. Astronomical instruments were obviously necessary for the latter to be feasible. Nicolaus Copernicus neither had the instruments, nor any opportunity to have them ordered. Therefore, he opted for making them all by himself. He decided against complex instruments, such as were used by Walther and Schoner, the Nuremberg astronomers, lacking a mechanic's workshop…

Copernicus made a quadrant for the observations of the Sun's meridian height during summer and winter solstice. However, he used this device rather occasionally. For the most part, he used another portable instrument – one known as "triquetrum", or "parallax instrument". This simple tool is also occasionally referred to as "Ptolemy's rulers". Copernicus made it himself, "rather accurately, of fir wood" ([44], page 54).

We reproduce an ancient drawing of this primary instrument used by Copernicus in fig. 11.26. It is so primitive that one cannot help doubting that Copernicus, a doctor, canon, administrator and governor,

could use two fir-wood planks to make a major astronomical discovery in between other endeavours. Specialists in the history of astronomy are apparently aware of some oddity here, which is why voice such sentiments as: "Crude as this instrument may seem at a first glance …" ([44], page 56).

It is most significant that the "ancient" Ptolemy was portrayed with the same two planks in the Middle Ages, qv in fig. 11.27. Could this astronomical instrument have remained unaltered for fifteen hundred years – the period that is presumed to separate Ptolemy from Copernicus? The artwork in question, however, leaves one with the impression that Ptolemy and Copernicus were contemporaries and used pretty much the same instruments.

Let us carry on. It is said that the observations that support the discovery of Copernicus were made in Frauenburg. However, we learn that "in general, Frauenburg was a very inconvenient place for astronomical observations. This is due to the geographical latitude of Frauenburg, which equals 54° 22' and complicates the observation of planets. Moreover, the view was further obscured by the frequent fogs rising from the sea, as well as the general abundance of clouds in these latitudes … However, Copernicus did not strive for great precision in his observations … According to the evidence of his apprentice and avid fan, Rheticus … he frequently said that he would … be happy if he could bring the error margin of his observations into the confines of 10' (10 arc minutes)". Whenever Rheticus would begin to argue and claim that one must make every effort to be as precise as possible, Copernicus pointed out the impossibility of this endeavour as well as the amount of labour required, warning his apprentice against 'ruminations of dubitable veracity' based on a priori imprecise observations" ([44], page 57).

This sounds reasonable and obvious, if we are to consider that Copernicus indeed lived at the very dawn of the epoch of astronomy in the modern meaning of the word – a science that employs an array of more or less precise instruments. According to our reconstruction, the time in question is when the primary materials for the final version of Ptolemy's Almagest were still being accumulated. The precise instruments of the mediaeval Ptolemy and Tycho Brahe either didn't exist, or were just being created in the XV-XVI century. It could be that the discovery eventually ascribed to Copernicus was made later, at the end of the XVI or even at the beginning of the XVII century, by which time the level of astronomical instruments grew substantially, and they were by no means made of cheap fir-wood planks.

But let us come back to the primary instrument of Copernicus – the one that was made of little planks of wood. It was "kept as a precious relic in Frauenburg for forty years after the death of the famous astronomer … Johann-Hanovius, Warmian Bishop, sent … the parallax instrument of Copernicus to Tycho Brahe as a present. The latter was delighted to receive this present, being a fan of Copernicus, although he had rejected his heliocentric system" ([44], pages 58-59). But in this case we are perfectly justified to ask whether the Copernican cosmology in its fully-fledged form was at all known in the epoch of Tycho Brahe. Could it be that the latter's reluctance to acknowledge the Copernican system should be explained by the simple fact that it did not exist in its final form. Brahe was forced to create a cosmology of his own as an attempt to develop Ptolemy's model. Tycho Brahe may have respected his predecessor Copernicus for astronomical merits of some sort, but hardly those ascribed to him today. We shall come back to this issue later.

Another oddity is as follows. Apparently, "no letters of Copernicus have survived – either those he sent to other scientists or the ones the scientists in question sent him in order to discuss his heliocentric cosmology" ([44], page 84). So let us reiterate. Could it be that the heliocentric system was finally formulated later than the first half of the XVI century – the end of the XVI century, for instance, or the beginning of the XVII? This could explain the absence of related correspondence in the first half of the XVI century.

7.2. Oddities in the Scaligerian story of how the book of Copernicus was published

We are told the following today: "Copernicus related his theory in two works. The first, "Lesser Commentary", was a small (12-page) essay – never printed and only distributed as handwritten copies. It was mentioned by Tycho Brahe; the manuscript itself was only discovered around the end of the XIX century [sic! – Auth.] in the book archives of Vienna (1877)

and Stockholm (1881). The main work of Copernicus entitled "On the Revolutions of Celestial Spheres" was published in 1543. A special courier brought several copies of the book to Copernicus, mortally ill at 70, on the very day of his death, on 24 May 1543" ([395], page 101).

Specialists in the history of astronomy tell us the following: "The issue of the date of the 'Lesser Commentary's' creation remains poignant to date" ([395], page 101). Also: "It was presumed lost; only by good fortune have two handwritten copies been found, one in the Library of Vienna, and the other – in the library of Stockholm Observatory" ([44], page 85).

Thus, the "Lesser Commentary", currently ascribed to Copernicus, a scientist of the XV-XVI century, has only been known since the end of the XIX century. We haven't managed to find any reliable data in works that mention him that predate the XIX century. It could have been written in the XVIII or XIX century by some astronomer as a brief rendition of the known main oeuvre of Copernicus. Therefore, one shouldn't base any hypotheses about the discovery of the heliocentric cosmology in the first half of the faraway XVI century on the "Lesser Commentary".

Figs. 11.28 and 11.29 reproduce the photograph of the beginning of "*De revolutionibus orbium coelestium*" as a manuscript. It is believed to be an autograph of Copernicus ([44], pages 12-13). However, it looks rather odd for a XVI century text. It is easy to read, the sentences are divided into individual words etc (see fig. 11.29). Could it be of a later origin, perhaps? We shall discuss the appearance of the authentic old texts of the XVI century at length in CHRON4.

In fig. 11.30 we see the title page of the first printed book of Copernicus – "*De revolutionibus orbium coelestium*", allegedly dating from 1543 ([44], pages 144-145). However, the publication date is transcribed as M. D. XLIII. The first Romanic letters (M and D) are separated from the rest by dots, qv in fig. 11.31. As we have explained in detail in CHRON1, Chapter 6:13, such dates can be interpreted in a variety of substantially different methods – for instance, as "43 years since the enthronement of the Great House" (Magnus Domus, or M. D.). The identity of the house in question (the beginning of a royal reign) shall be an altogether different question, with a variety of possible answers. Therefore, one must be extremely cautious

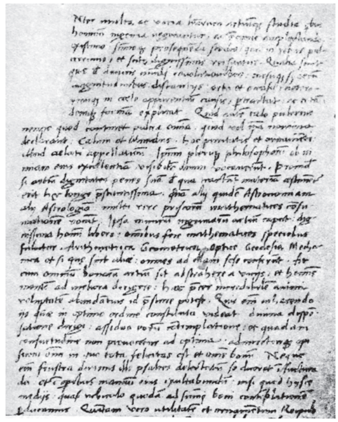


Fig. 11.28. The beginning of the manuscript entitled ***On the Rotation of the Celestial Circles*** ascribed to Copernicus nowadays. The original is kept in the Copernican Museum in Frauenburg. Taken from [44], inset between pages 12 and 13.

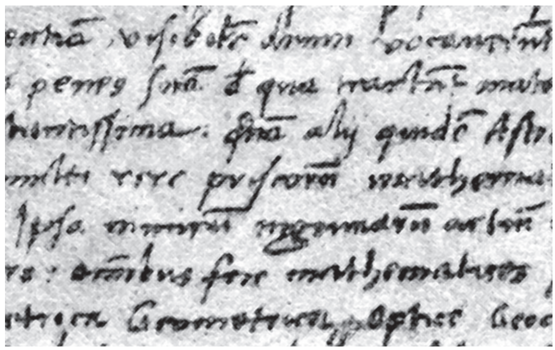
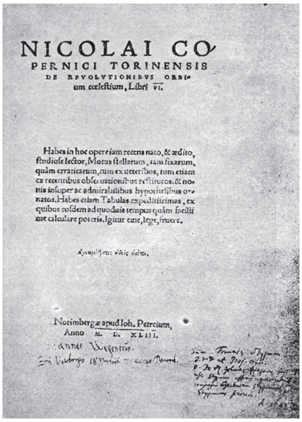


Fig. 11.29. A close-in with a fragment of the Copernican manuscript. Taken from [44], inset between pages 12 and 13.

when one claims the date in question to be 1543 A.D. A different interpretation might yield a date pertaining to the beginning of the XVII century. See CHRON1, Chapter 6.

Why is Copernicus believed to have vehemently opposed the publication of his discovery all his life, getting a copy of the book on his dying day? Specialists in history of astronomy have long noted this rather strange "Copernican reticence", proposing a variety of theories to explain it. This, for example, is what I. A. Klimishin has to say on the subject: "Copernicus appears to have finished work on his oeuvre entitled '*De revolutionibus orbium coelestium*' in 1532.


NICOLAI CO
PERNICI TORINENSIS
DE REVOLVTIONIBVS ORBI-
um cœlestium, Libri VI.

Habes in hoc opere iam recens nato, & ædito, studiose lector, Motus stellarum, tam fixarum, quàm erraticarum, cum ex ueteribus, tum etiam ex recentibus obseruationibus restitutos: & nouis insuper ac admirabilibus hypothesibus ornatos. Habes etiam Tabulas expeditissimas, ex quibus eosdem ad quoduis tempus quàm facillime calculare poteris. Igitur eme, lege, fruere.

Norimbergæ apud Ioh. Petreium,
Anno M. D. XLIII.

Fig. 11.30. Title page from the book of Copernicus, ***On the Rotation of the Solar Circles***. Presumed published in 1543. However, the date M. D. XLIII that we encounter here can be interpreted in a variety of ways. Taken from [44], inset between pages 144 and 145.

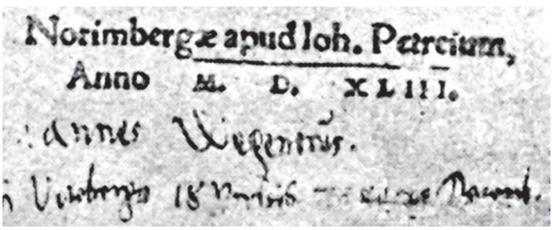

Norimbergæ apud Ioh. Petreium,
Anno M. D. XLIII.

Fig. 11.31. A close-in with the date on the title page of the Copernican book. Taken from [44], inset between pages 144 and 145.

He only published it eleven years later, after persistent persuasion from the part of his friends and avid supporters. Why would that be? Some voice the presumption that Copernicus was afraid of the church persecuting him. Others suggest that he was a very modest man and did not want his name to become too famous. However, we have already witnessed the fact that all his de facto ecclesiastical superiors were urging the publishers to launch the book into publication as soon as possible. The persecutions only started a century later" ([394], page 104).

The answer might be as follows. Modesty has got nothing to do with it. It is likely that the final version of the Copernican oeuvre was only written in the early XVII century – or even the original version, come to think of it, which is when the socio-political and ecclesiastical dissent in Western Europe reached its peak. It would indeed be dangerous to publish the final heliocentric conception in such an environment. This is why the editors of the book (or its real authors - from the clique of Johannes Kepler, for example) did the perfectly sane thing – they did publish the book, but ascribed it to an astronomer who died more than fifty years ago – Copernicus, the doctor, canon and administrator who may indeed have been the first to have voiced the inspired, but yet rather vague and half-formed, conceptions of the heliocentric system.

Hence the legend that Copernicus never saw his book published – namely, that it was placed into his chilling hands on the day of his death. "Gassendi, the first biographer of Copernicus [a XVII century author, as we feel obliged to remind the reader – Auth.], tells us the following about the last days of the astronomer: 'The time of his last ailment almost coincides with the publication of his magnum opus … Several hours before his death, a copy of his freshly printed work was brought to him … He took the book into his hands and stared at it, but his thoughts were already far away'. Repercussions of this story told by Gassendi can be found in virtually every subsequent biography of Copernicus" ([44], page 109).

The very structure of this book's first version strikes one as most bizarre indeed. For one, it has a lengthy title that amounts to some 13 lines of modern text ([44], page 149). However, we are told that "the only part of this sophisticated and advertisement-like title that was really authored by Copernicus can be reduced to 'On the Revolutions of Celestial Circles, VI books'. The rest was written by Osiander" ([44], pages 149-150). And so, we are suddenly introduced to Osiander, some mysterious co-author and the alleged editor of the book. Incidentally, the name itself might translate along the lines of "Asian Man", or "Man of Jesus", which makes it a likely moniker, especially given that it is nearly "symmetrical" to his name Andrew, and looks very much like an example of typical Mediaeval cabbalist wordplay. Andreas Osiander is presumed to have lived in 1498-1552 ([926], page 59).

Furthermore: "Osiander didn't restrict himself to these two insets on the title page. He has also written a foreword, which distorted the very spirit of the Copernican oeuvre. Since this foreword remained un-

signed for a while, many attributed it to Copernicus and remained errant for a long time" ([44], pages 149-150). I. A. Klimishin writes the following: "Lies nest on the very first pages of the Copernican oeuvre, disguised as a foreword by Andreas Osiander, a Lutheran theologian (1498-1552) charged with the editing of the book" ([395], page 114). Let us remind the reader that Copernicus was a Catholic; moreover, not any mere Catholic, but one vested with the duties of a bishop ([44], page 76). Therefore, it strikes one as highly improbable that he would trust a Lutheran theologian with the editorship or even the foreword. After all, we are told that the relations between Catholics and Lutherans were extremely strained in the XVI. However, Kepler was a Protestant, and we would be perfectly justified to expect a foreword by a Lutheran theologian in a book whose publication he took part in, qv below.

It is presumed that certain friends of Copernicus protested against the publication of a book with such a foreword, but to no avail, since the Copernican magnum opus "was already widely sold" ([44], page 150). Let us also pay attention to the following piece of information: "The foreword written by Copernicus himself could only be published 300 years later" ([926], page 59).

Aren't these vague legends concerning the publication of the book a reflection of the editing that continued well into the XVII century? After all, we are told that "1000 copies of the book by Copernicus were printed in 1543; new publications took place in 1566 (Basel) and 1617 (Amsterdam)" ([395], page 113). One must mark straight away that the "new edition of 1617" already dates from the epoch of Johannes Kepler. Therefore, taking all the above oddities into account, one has got every right to ask the following question: is it true that the "previous editions" really date from 1543 and 1566, and not any later date? We have already debated that such dates as M. D. XLIII may be interpreted in a variety of ways.

Moreover, we prove it in Chron1, Chapter 6:13.5 that the publication dates of certain printed books dating from the XVI-XVII century may be in need of being brought closer to our time chronologically, by fifty years at least. The result might be that the date of the first publication of the Copernican oeuvre shall be circa 1593 and not 1543, as it is believed today – once again, the epoch of Kepler.

Our opponents might counter as follows: weren't the "Prussian Tables of Celestial Motion", presumably compiled on the basis of the Copernican theory, published in the alleged year 1551, as it is believed today ([395], page 104)? New editions of the tables came out in the alleged years 1571 and 1584; they "became the basis for the calendar reform instigated by Pope Gregory XIII in 1582 – also known as the introduction of the 'new style'" ([395], page 104). Our reply shall be identical to the above reply to the question about the Copernican book. The time of the calendar reforms falls over the end of the XVI century, some 50 years later than the alleged first publication of the book of Copernicus. The Prussian tables were compiled in the alleged years 1571 and 1584, and also require additional analysis. It is possible that the text of the Tables that has reached our time actually dates from a later epoch. Moreover, the calendar reform of 1582 may well have been carried out without the heliocentric cosmology. All the theoretical calculations necessary for the reform are easily feasible without the Copernican theory, especially given that historians themselves make the following perfectly justified remark: "Prussian tables had no tangible advantage over the 'Alfonsine tables'" ([926], page 61).

7.3 Why it is believed that Tycho Brahe "did not accept the theory of Copernicus". In reality, the system invented by Tycho Brahe is identical to the Copernican

We are told that Tycho Brahe revered Copernicus and was familiar with his work, but failed to accept the heliocentric model for some reason: "Tycho had a very high opinion of Copernicus, whose portrait was installed at the most conspicuous place in the observatory" ([395], page 131). And yet "Tycho did not accept the Copernican system" (ibid). The feeling of oddity grows once we become familiar with the exalted verse ode allegedly written by Tycho Brahe about the Copernican system upon reception of the present of the wooden parallax instrument manufactured by Copernicus himself. Fragments of this ode translated from [44], page 59, are as follows:

"That noble man, Copernicus, I trust
To have this devious contraption made,
Thereby pursuing a deed most daring …"

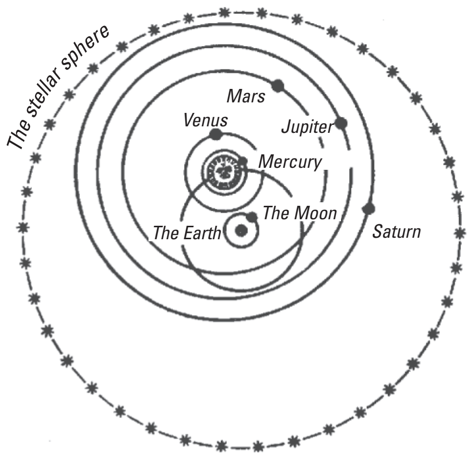


Fig. 11.32. The diagram is de facto a representation of Tycho Brahe's heliocentric system. The initial reference point coincides with the position of the Earth (in other words, the observer is located upon Earth surface). However, all the other planets rotate around the Sun. If we are to disregard the choice of the initial reference point, we instantly see that all the planets rotate around the Sun. The Copernican scheme in its initial form shall result from shifting the reference point (or the observer) to the Sun. The heliocentric system of Tycho Brahe must have been conceived earlier than the system presently ascribed to Copernicus – allegedly a predecessor of Tycho Brahe. Taken from [395], page 132.

It goes on and on, remaining quite as exalted and hopelessly romantic. Specialists in the history of astronomy also report the following, and quite correctly so: "This is the ode written by Tycho Brahe to glorify his [Copernicus's – Auth.] cosmology and the effect it had on his contemporaries" ([44], page 60). In this case, the scientific position of Tycho Brahe becomes even more bizarre. To be so deeply impressed by the Copernican cosmology and yet to reject it, no less! What could possibly be the case?

We are in favour of a simple explanation. Apparently, the final formulation of the heliocentric system only took place in the epoch of Brahe, the previous epoch being one of creation and realisation. The history of astronomy claims Tycho Brahe to have created a cosmology of his very own, one that included elements of both systems: Ptolemaic and heliocentric ([926], page 67). This creation was by no means of a speculative nature, but rather the result of an important astronomical discovery that he had made. Tycho Brahe observed comets, calculating their orbits, and made the corollary that destroyed one of the primary ideas behind the Ptolemaic system. Namely, he realised that the "hard crystal spheres" could not exist in reality – otherwise they would interfere with the motion of comets ([395], page 131). Brahe's idea was simple – and yet revolutionary. He made the discovery that the orbits of comets were greatly elongated, and must therefore intersect the orbits of other planets, crossing the respective "crystal spheres", which the XV-XVI century astronomers believed to exist. It becomes obvious that this discovery of Brahe was indeed an impetus for a massive paradigm shift. In the case of Copernicus, we are told nothing factual about his motivation for the discovery of the heliocentric system – just the legend of two fir-wood sticks, albeit very neat.

The Tychonian cosmology is shown in fig. 11.32. The same as depicted in an ancient map can be seen in figs. 0.26 and 0.27 that accompany the Foreword. The Earth remains the centre of the Universe, with the Sun revolving around it. However, all the other planets already revolve around the Sun. This is precisely why the system of Tycho Brahe is referred to as geo-heliocentric today ([395], page 132). It is perfectly obvious, though, that it only differs from the "Copernican system" in terms of initial reference point selection for the coordinate system. That is the only difference. As we know from the school course of physics and mathematics, an altered reference point does not affect the actual system of mobile bodies, all that changes is the coordinate system – the location of the observer, if you will. In other words, it is the view that changes, not the actual landscape.

Let us once again consider the system of Tycho Brahe as depicted in fig. 11.32 and the ancient map (figs. 0.26 and 0.27, Foreword). In reality, from the kinematics point of view, this is a perfectly valid heliocentric cosmology, the only difference being that the centre of the reference system is the Earth. However, we know that the centre of a coordinate system can be anywhere – linked to any mobile body in the system, for one. If we transfer the initial reference point in Tycho Brahe's diagram to the Sun, we shall instantly come up with the "Copernican system" without introducing any fundamental changes. The Earth will revolve around the Sun, and all the other plan-

ets already revolve around the Sun in Tychonian cosmology. The somewhat elliptic shape of the planetary orbits is all this system lacks to transform into the finite system as devised by Kepler. Brahe's planetary orbits are all circular, as well as their Copernican counterparts. However, this effect is of a secondary nature. Let us reiterate – the heliocentric system of Tycho Brahe is de facto the Copernican system, with a differently chosen initial reference point. The difference is that the hypothetical observer is located on the Earth and not on the Sun. It is very odd that no specialist in the history of astronomy has ever mentioned this, and odder still that they claim Tycho Brahe to have "rejected the heliocentric system", since they have known the heliocentric drawing of Brahe for quite a long time.

It is obvious that the Tychonian concept preceded the Copernican idea, or coexisted with it. A better way of putting it would be to say that both concepts were identical. The "Copernican system" with the coordinate system beginning at the centre of the Sun is the evolutionary descendant of the Tychonian system, or a contemporary of the latter at the very least, but by no means a predecessor. In other words, the final "picture" of the heliocentric system must postdate Tycho Brahe and date from the epoch of Johannes Kepler, his apprentice, ascribed to the XV-XVI century scientist Copernicus in retrospect.

Therefore, the Scaligerian version that we are offered today, which claims the Tychonian system to be an odd mixture of the Ptolemaic system with the "already well known" system of Copernicus, is erroneous. This "explanation" has only come into existence due to the confusion of the specialists in the history of astronomy produced by the chronology of Scaliger and Petavius, which makes the Copernican system predate the system of Tycho Brahe. On the other hand, they knew it quite well that Tycho Brahe invented his cosmology himself and did not borrow it from anyone – the following is reported, in particular: "Tycho's own observations of planetary motion led him to the conclusion that Ptolemy's system was indeed incapable of explaining the observed phenomena" ([395], page 131).

Historians were put into a very embarrassing situation. How would one reconcile these contradictory facts with each other? They appear to have thought of a "solution", dubbing the Tychonian system "geo-heliocentric" and not heliocentric proper. The system was claimed to be non-Copernican, on the flimsy pretext that the initial reference point chosen by Tycho Brahe for his diagram was the Earth and not the Sun (allegedly in error). Once again, let us reiterate – the initial reference point of a coordinate system is of no vital importance, especially to a professional scientist. Every mathematician or astronomer is aware that the initial reference point can be put wherever it is the most convenient for the purposes of research. The actual system of mobile bodies is obviously not affected in any way. Even today the Earth is often chosen as a reference point when configurations of celestial bodies visible from the Earth are the issue. However, the general public might consider the shift of a reference point as a radical alteration of the system. This is all a question of advertising the material. This simple method was used by the specialists in the history of astronomy in order to ascribe the same cosmology to both Copernicus and Tycho Brahe, thus solving the problem. Then they started to preach about the fundamental differences between the two systems until they converted themselves and even wrote a little ode on behalf of Tycho Brahe. Such literary embellishments of his work are most likely to be "credited" to certain scientists of the XVII-XIX century; the same is true about the books of Copernicus and Kepler.

Modern astronomers are for some reason extremely puzzled about the fact that "Tycho Brahe considered his cosmology extremely important and even believed the justification of its primary postulations by careful observation to be the work of his lifetime" ([926], page 67). This is what Dieter Herrmann, the first director of the Berlin Observatory, has to tell us. And yet there is nothing to be surprised about in Tycho Brahe's stance – the scientist who discovered the heliocentric system of the universe could not be unaware of its paramount importance. Few manage to make discoveries of this calibre. So modern astronomers are thoroughly wrong to adopt a patronising attitude towards Tycho Brahe, expressing it in such ways as: "Brahe hasn't managed to develop a single theory that would concern the motion of celestial objects … The lack of a theoretical basis could possibly be explained by Brahe's limited abilities …

Fig. 11.33. The frontispiece of the ***Celestial Machine*** by Johannes Hevelius, published in 1673. "One sees Copernicus and Tycho Brahe, standing". Taken from [44], inset between pages 160 and 161.

Fig. 11.34. Ancient engraving showing Ptolemy, Copernicus and Tycho Brahe as contemporaries, or astronomers of the same epoch. Taken from [550], page 173.

Brahe realised that the task in question was too complex for him" ([926], pages 68-69).

It is all the more astonishing that some of Tycho's critics, such as Herrmann with his patronising remarks, have had the diagram of Tycho Brahe's planetary system in front of them all along ([926], page 67; see fig. 11.32) – and it is very clearly a heliocentric cosmology with the Earth being its initial reference points. What we see is the most blatant kind of disinformation imaginable. Cui bono?

The true chronological cosmology sequence must have been as follows.

1) The Ptolemaic geocentric system came first. Its complex epicycle scheme apparently dates its formation to the XV-XVI century. Earth was placed at the centre of the Universe when this cosmology was created, the initial concept being one of an immobile Earth. The motion of planets as observed from the Earth required a very complex epicycle system to explain it. The first version of the cosmology was based on the "regal" star catalogue created in the epoch of the XI century A.D. Its creation was associated with the birth of Christ in the XII century A.D. and the supernova flash in 1152 A.D., or the Star of Bethlehem. The first Christian astronomers of that faraway epoch compiled the star catalogue to honour Jesus Christ, hence the immense authority of this catalogue. It remained in circulation more or less unaltered up until the very XVI century. It would be apropos to recollect the fact that the star catalogue included by Copernicus into his

book, the so-called "Copernican catalogue", is in reality the very same old Ptolemaic catalogue, albeit rendered to another epoch by choice of a different initial reference point. This obvious fact has long been known to the specialists in history of astronomy. For example, this is what I. A. Klimishin writes about the catalogue in the book of Copernicus: "The catalogue of 1024 stars is also reproduced here. This is basically Ptolemy's catalogue – however, the longitudes are counted off γ Ari and not the vernal equinox point" ([395], page 109). This fact makes it particularly obvious that the astronomers of the Middle Ages customarily shifted the initial point of reference, transferring the "precession-based catalogue date" to the epoch they chose for whatever reason. In the XV-XVI century the astronomers took another step forward and started to develop the theory of planetary motion, which accounted for the Earth and the Sun. This was the birth of the "Ptolemaic system". Incidentally, it is said that "the structure of the Copernican oeuvre is very similar to the Almagest" ([395], page 105). Our reconstruction explains this fact perfectly well, since the final version of the Almagest was only ready in the XVI-XVII century.

2) Simultaneously with Ptolemy's planetary conception, the system of Tycho Brahe = "the ancient Hipparchus" was created in the second half of the XVI century, as we note in Chapter 10. As we already mentioned, this conception was de facto heliocentric, given that the motion of all planets but the moon occurs in circular patterns within this system, the Sun being its centre. However, it is suggested to associate the initial reference point in the heliocentric system of Brahe with the Earth.

3) Finally, the heliocentric system with the Sun chosen as the initial reference point. This system is novel to some extent, but not in any substantial way (cosmologically, that is). The only thing that is truly innovative is that the beginning of the coordinates system doesn't necessarily have to coincide with the position of the observer – the Earth, for instance. It may as well be the Sun. This made the picture much simpler for the general public as well as schoolteachers.

This system is likely to have entered astronomic practice in the XVII century – the epoch of Kepler. For some reason, it was credited to an astronomer of the XV-XVI century in retrospect – a certain Copernicus. He must have truly been a talented astronomer. It is possible that he was the author of the initial "raw" version of the heliocentric idea with the Sun, and not the Earth, as the initial reference point. However, we find it very difficult to say what it was precisely that he did. We are of the opinion that the above texts make it perfectly clear that all we know about the life and the endeavours of Copernicus comes from XVII century texts – ones written 60-100 years after his death for one reason or another.

We are of the opinion that both systems (Ptolemaic and Tychonian = Hipparchian, also known as the Copernican system) date from the same epoch of the XVI-XVII century. The systems competed and were actively discussed by the astronomers until it became clear that the most correct system is the Tychonian heliocentric model. However, later historians deprived Tycho Brahe of this discovery, which they credited to Copernicus in its entirety.

In fig. 11.33 we see an ancient engraving of 1673 from a book by Hevelius that portrays Copernicus side by side with Tycho Brahe ([44], pages 160-161). Another old engraving that depicts Copernicus, Tycho and Ptolemy can be seen in fig. 11.34. They look like colleagues and contemporaries, discussing scientific problems at their leisure. The fact that Tycho Brahe was the first discoverer of the heliocentric system, as we are beginning to realise, makes his astronomical merits all the more impressive. "According to Kepler, in his last days Tycho often whispered '*Ne frustra vixisse videar!*', or 'My life wasn't wasted in vain!'" ([395], page 128).

7.4. Is it true that the book of Copernicus, first published in the alleged year 1543, has reached us in its initial shape and form?

Let us consider the initial form of the Copernican system in greater detail. Most usually, modern publications about Copernicus reproduce the planetary system drawing from the very first edition of his book, allegedly dating from 1543 (fig. 11.35). However, there is yet another oddity about the book of Copernicus concealed here. K. L. Bayev is perfectly write to report the following: "First of all, let us remind the readers that Copernicus had preserved the epicycles of the

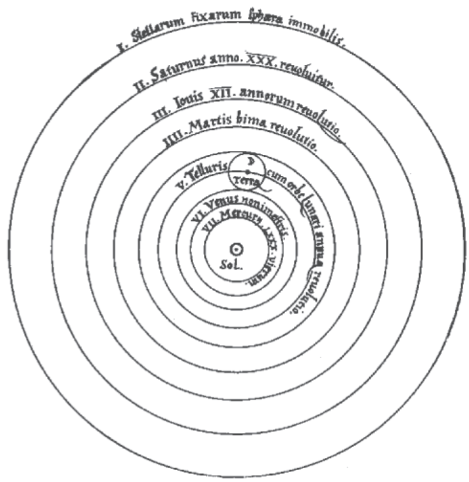


Fig. 11.35. The diagram of Copernican cosmology from the first edition of his book, ***On the Rotation of the Celestial Circles***, allegedly dated to 1543. We see no epicycles here, which might leave one with the false impression that Copernicus rejected them altogether. However, this isn't so in reality. See more on this below. Taken from [395], page 108, and [44], page 175.

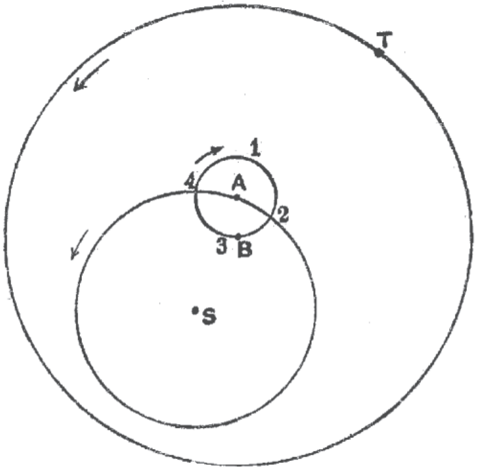


Fig. 11.36. Telluric motion around the Sun according to Copernicus. The Earth (T) rotates around point B, which, in turn, rotates around the Sun (S). Thus, the Sun isn't located in the centre of the Universe, and the Earth rotates around auxiliary point B and not the Sun, strictly speaking. This system isn't purely heliocentric as to yet. Thus, one finds different versions of the "Copernican" planetary system in different parts of the book ascribed to Copernicus and known to us today. Taken from [44], page 177.

old Ptolemaic theory and the eccentrics of Hipparchus. The illustration [see fig. 11.35 – Auth.] contains a diagram of the Solar system according to Copernicus (from the first edition of '*De Revolutionibus …*'). However, this illustration, which one is sure to find in every textbook and popular book on astronomy, does not depict any epicycles. It is a common misconception that Copernicus rejected all the epicycles of the old theories in his book. This is wrong, however – in order to demonstrate this to the reader, we provide an illustration [see fig. 11.36 – Auth.], which is a diagram of the Earth's motion around the Sun in the system of Copernicus. The Sun is point S; point A rotates around it going in a circle from the West to the East making a full cycle once every 53000 years, more or less. Point B is the centre of the orbit of the Earth, whose radius equals BT – it rotates around point A, in turn, but in the opposite direction, as indicated by the arrow, making a full cycle in 3434 years. Therefore, the Sun isn't in the centre of the Earth's circular orbit in Copernican cosmology, but lays 'sideways', as it were. Copernicus uses similar constructions for other planets" ([44], pages 177-178).

D. Herrmann writes the following in this respect: "This wile brings Copernicus back to the methods of the ancient astronomy, in a way, making him surpass even Ptolemy in this line" ([926], page 58).

However, in this case it turns out that the edition of the Copernican oeuvre that dates from the alleged year 1543 contains different "Copernican" cosmologies in its different parts. On the other hand, according to certain specialists in the history of astronomy, "Copernicus was forced to make his theory more complex by the introduction of epicycles" ([44], page 179). Obviously enough, this was a step forward in comparison to the Ptolemaic system, and we agree that "no matter how much the theory of Copernicus was made more complex by the introduction of additional motion that we said nothing about, it was much simpler than Ptolemy's" ([44], page 179). Copernicus wasn't yet aware that the planets had an elliptic trajectory, and, keeping some of Ptolemy's epicycles, tried to make his theory concur with the observation data.

On the other hand, a draft from the same book of Copernicus that you can see in fig. 11.35 is much more correct. The Sun is at the centre of the planetary system here. The problem is, however, that the

eccentricities of planetary orbits are rather small, and that a detailed depiction of ellipses makes them virtually indistinguishable from circles. Who would include this draft of a de facto up to date model into a book ascribed to Copernicus? Could it be Kepler in the XVII century, after the discovery of the marginally manifest elliptic nature of orbits and the initial realisation of the epicycles' extraneousness?

The draft from the Copernican book (qv in fig. 11.36) is obviously an attempt to take the next step forward after Tycho Brahe - namely, to model the elliptic nature of the Earth's orbit around the Sun with the aid of epicycles. Kepler shall soon realise that the orbit of the Earth is similar to the orbits of other planets in its elliptical nature. For the meantime, however, the aberrations of the allegedly circular planetary orbits are explained as caused by a certain epicycle system.

If we are to agree with the Scaligerian viewpoint, the attempt of Copernicus to model the elliptic nature of planetary orbits in the very first edition of his book looks odd at the very least. Indeed, the very limitedly manifest elliptic nature of orbits is an effect of a secondary nature as compared to the discovery of planetary rotation around the Sun. The implication is the Copernicus, having just discovered an amazingly simple cosmological system, immediately started to complicate it by adding a convoluted epicycle system. This is possible, but odd nonetheless. Whenever researchers delve into particularities in this manner, they are usually at a stage when the primary picture is more or less clear and had been explained to the scientific community previously. As we have witnessed, Tycho Brahe doesn't make a single attempt to account for the slight aberration of planetary orbits from the circular form. We must once again emphasize that this aberration is minute in reality. Therefore, the heliocentric system of Tycho Brahe makes the impression of an earlier origin than the system we see in the Copernican oeuvre, which doesn't merely contain the conception of the heliocentric system, but also makes the following steps concerning an issue that is more complex mathematically and more specialised – the somewhat elliptic shape of planetary orbits. This issue was only raised in the XVII century science.

Therefore, we cannot rule out the possibility that the version of the Copernican oeuvre that has reached our day and age remained in edition for a long enough time – up to Kepler.

7.5. Could Johannes Kepler be the editor or even co-author of the "canonical version" of the Copernican oeuvre known to us today?

The common opinion is that Kepler (1571-1630) "had been a staunch Copernican from the very start" ([926], page 72. Apparently, in the alleged year 1596 "he published his first work entitled 'A Cosmographical Mystery', wherein he defended the Copernican system" ([44], page 208. The book in question is Kepler's "*Prodromus Dissertationum Cosmographicarum continens Mysterium Cosmographicum*" [926], page 70.

History of astronomy reports that Kepler wrote the book that contained the first consecutive and finite version of the Copernican theory. Namely, "Kepler's book '*Epitomae Astronomicae Copernicanae*' ('The Encapsulated Copernican Astronomy'), came out in three parts – in 1618, 1620 and 1621, around 1000 pages of text altogether. It was the very first textbook on astronomy based on thoroughly novel principles. The centre of the planetary system is occupied by the Sun in the 'Astronomy', with the planets revolving around it in circular orbits" ([395], page 147).

It is spectacular that by that time "the teaching of Copernicus was already persecuted … By 1629 the '*Epitomae*' were in the list of banned books, remaining there up until 1835" ([395], page 149-150). The discoveries made by Kepler himself were published in the work entitled "New Astronomy". One must note: "this truly innovative work saw light in 1609 as a small number of copies, with neither the publisher, nor the publishing house named anywhere" ([926], page 72). Apparently, Kepler was afraid of persecution (or, alternatively, the editors were afraid of the repressions that the publication of his book could bring in its wake.

The final version of the Copernican cosmological system *as formulated in Kepler's works* came out in the atmosphere of a severe conflict with the church. We learn the following important fact: "In 1616 the teaching of Copernicus was declared heretical … the book … of Copernicus was 'to remain under arrest until rectification'" ([44], page 193). This is how this de-

cree of 5 March 1616 sounded. We cite fragments: "Since it became known to the above congregation that the false teaching of the Pythagoreans, which contradicts the Holy Writ in every way, as preached by Nicolaus Copernicus in his book 'On the Revolutions of the Celestial Spheres' and Didacus Astunicus in 'Comments to Job', has spread and become accepted by many … The congregation deems it proper to withdraw said books from circulation … until the day the necessary amendments are introduced" (quoting in accordance with [395], pages 158-159).

Four years later, in the middle of May 1620, the congregation came back to this issue. The following was declared: "The Holy Congregation of the Index states that the work of the famous astrologer Nicolaus Copernicus 'On the Revolutions of the Celestial Spheres' is to be condemned utterly … It is henceforth only permitted to publish the book of Copernicus upon introduction of the following corrections" (quoting in accordance with [395], page 159).

This information is vital. We see that in the early XVII century the Copernican cosmology was banned, and his book arrested for correction. One mustn't doubt it that the orders were followed and that someone did edit or rewrite the book of Copernicus, subsequently publishing the altered version as a "slightly corrected" one. This took place in the epoch of Kepler. Therefore, one has very serious reasons to doubt the fact that the authentic first edition of the Copernican book dating from the alleged year 1543 has survived until our days. Most likely, the previous version (if one did exist before Kepler, that is) was heavily edited in the XVII century and published with the "old date", after the destruction of the original.

And thus, if anyone attempts to convince the scientific community that the existing version of the book of Copernicus is identical to the original published in the alleged year 1543, this will have to be proved specifically. Due to the perfectly clear orders of 1616 and 1620 that the book be "amended", no such attempt is likely to ever succeed.

According to our reconstruction, the fragmentation of the Great = "Mongolian" Empire began in the early XVII century. A wholly new epoch of the Reformation mutiny began. Old imperial institutions were replaced by new ones all across the Western Europe. History in general was being altered, as well as the history of sciences. As we are beginning to realise, the book of Copernicus did not escape the questioners' attention.

Scaligerite historians occasionally report that Luther and Melanchton spoke out against the Copernican system in the XVI century. However, a closer study of the issue reveals that the data are very ambiguous. This is what I. A. Klimishin has to tell us on the subject, for instance: "The presumed hostile attitude of the Protestants towards Copernicus, and Luther himself in particular in 'Table Talk' … It would be expedient to recollect the fact that Luther himself didn't write 'Table Talk' – a recording of table conversations recorded in a clandestine way from memory by one of his more industrious apprentices. They remained unknown for several centuries and were only published in our century. In reality, the Protestants were quite loyal towards the Copernican teaching" ([395], page 102). Incidentally, Melanchton called Copernicus a "Sarmatian astronomer" ([926], page 61).

A very important circumstance is therefore revealed. The information about Luther being critical of Copernicus was first published in the XX century – likewise Luther's "Table Talk".

It could be that the Protestants did not criticise Copernicus in the XVI century due to the non-existence of his book in that epoch. The entire issue of Luther's and Melanchton's attitude towards the Copernican model must have been raised in the XVII century the earliest, which is about the same time others started to refer to "the classics" as well. Some (Kepler, for instance) said that the heliocentric system was invented by Copernicus in the XVI century (thus being a classic of astronomy, that is). His opponents claimed that other classics, namely, Luther (or Melanchton) spoke out in indignation against the heliocentric teaching even then. The necessary "body of evidence" such as the letters of the classics or the recordings of their intimate table talk would never be in short supply, and has always fallen into right hands. Therefore, the XVII century struggle led to a confrontation between "XVI century classics", who had been quite unaware of it and actually friendly in real life.

It is possible that in the epoch of military, political and religious unrest of the XVII century Kepler thought it dangerous to sign the final version of the

heliocentric planetary system concept by his own name, with the beginning of the coordinate system coinciding with the Sun, the centre of the world. The opinion about this version contradicting the Bible must have already existed by that time. Let us recollect the incineration of Giordano Bruno in 1600 by the orders of the Inquisition ([926], page 76). Accusations against Galileo and Kepler were voiced as well. "In 1616, a congregation of 11 Dominicans and Jesuits started a process against the teaching of Copernicus in Rome … By the verdict of the experts of the Holy Tribunal, the Copernican teaching as followed by Galileo was declared insane and absurd … not to mention absolutely heretical … It took a two-day session to ban the work of Copernicus" ([926], page 79).

Specialists in the history of science report the following: "Given this tense political atmosphere, the decree of 5 March [1616 – Auth.] … made a grave impression among the scientific community … The third Amsterdam collection of Copernican works came out in 1617; the fourth one was published in Warsaw as late as in 1854, after the acquiescence of Pope Pius VII for the publication of books where the motion of the Earth and the immobility of the Sun are interpreted from the viewpoint of modern astronomy was received. The works of Copernicus, Kepler, Galileo and Foscarini were removed from the index of banned books in 1835" ([946], page 134).

Therefore it turns out that after 1617 the book of Copernicus remained banned from publication for 237 – over two centuries! As we can see, the first Polish edition of Copernicus only dates from the middle of the XIX century. Why would the work of the greatest Polish astronomer of the XVI century be first published in his homeland 400 years after his death?

Let us recollect that the first edition of the Copernican oeuvre came out in Nuremberg in the alleged year 1543. The second edition was published in Basel, in the alleged year 1566, the third – in Amsterdam, in the alleged year 1617, and, finally, the fourth edition came out in Warsaw in 1854 ([946], page 134).

D. Herrmann, an astronomer and a specialist in the history of astronomy, writes the following: "Persecutions that had already claimed Giordano Bruno as their victim and were becoming ever harder for Galileo made Kepler very circumspect indeed. In 1617, right after the inquisition's first process over Galileo, there was an attempt to summon Kepler to Bologna, which was met with a decisive refusal – Kepler claimed he would not suffer insults from informers" ([926], page 81-82).

Despite all of Kepler's precautions, "in 1618 … Kepler's 'Encapsulation of Copernican Astronomy' was banned" ([946], page 135). It wasn't just Copernicus that they banned, in other words, but also Kepler's works about Copernicus. As a result, some of Kepler's works were also withdrawn from scientific circulation for some time. It didn't end there. In the early XVII century the heliocentric theory became so grave a matter that Kepler was forced to take drastic measures, going so far as feigning a change of confession. The following vivid fact is reported, for example: "Matters went so far that in his 'World Harmony', an oeuvre dating from 1619, Kepler the Protestant presents himself as a staunch Catholic" ([946], page 135). One must say, truly great scientists are very seldom forced to resort to "mimicry" of this kind.

All of the above leads us to the very obvious conception that Kepler and his colleagues apparently had to "deprive" themselves and the great Tycho Brahe of the heliocentric conception and ascribe it to a famous astronomer who had lived a century earlier. Especially assuming that Copernicus indeed formulated a raw version of this conception in the XV-XVI century. The romantic legend about Copernicus seeing his book published on his dying day must be a reflection of the very same circumstance, namely, that the book was published long after the death of Copernicus. The XVII century may have placed the book in the hands of the dying Copernicus purely symbolically, paying their dues to his authorship of the heliocentric idea in its initial form.

We must reiterate that most works attributed to Copernicus, Tycho Brahe and Kepler today must have been created later, in the XVII-XIX century, and ascribed to them in retrospect so as to justify the history of astronomy in its Scaligerian version.

Let us conclude with asking the following question, which has the character of a general remark, and yet might prove useful for the analysis of the convoluted and distorted history of astronomy in the XVI-XVII century. It is a random occurrence that the name "Copernicus" sounds somewhat similarly to "Kepler + Nike", or "Kepler the Victor"? Without vo-

calisation, we end up with CPR + NC and KPLR + NK. We have already seen that Kepler took part in the propagation of the Copernican teaching in the XVII century. Could this be yet another chronological shift, one of circa 100 years? Kepler is presumed to have lived in 1571-1630, and Copernicus – in 1473-1543. According to Scaligerian chronology, these two astronomers are roughly one century apart. A 100-year shift was already discovered in the research of mediaeval dynasties – the history of Russia, for example, qv in CHRON1 and CHRON4. Scaligerian history considers both scientists great astronomers and discoverers of fundamental laws.

We have already found out, for instance, that the famous XVII century chronologist Dionysius Petavius ("the Lesser", or "the Small") drew "a picture of himself" in the distant past as "the famous VI century chronologist Dionysius the Little" (see CHRON1 and CHRON2). The chronological shift equals about 1000 years here.

Another possible interpretation of Copernicus's name is "Cyprenicus", or "Scientist from Cyprus", someone who worked or lived there or was related to Cyprus in some way. Let us recollect that Cyprus is a large island in the East of the Mediterranean, off the coast of Asia Minor. It was a famous location in the Middle Ages (for its copper mines in particular). This is where its name is likely to come from – the Latin for "copper" is "*cuprum*" and also "*cyprus*" ([237], page 284). Thus, a Cypriote could become "*Kopernik*" in the Slavic languages and then "Copernicus" in Latin. Incidentally, we have already mentioned the fact that Copernicus was known as a "Sarmatian" (or Slavic) astronomer ([926], page 61). We must also note that the geography and climate of Cyprus are a great deal more appropriate for astronomical observations than the foggy Frauenburg. Apart from that, Cyprus is geographically close to the "ancient" observatories, since it is right in between the Isle of Rhodes and the Egyptian Alexandria.

7.6. The heliocentric cosmology and the Biblical "stopped sun"

Let us note that the idea of making the Sun the centre of the Universe – which can be referred to as "stopping the sun", or making it immobile, after a certain manner, dates from the very same epoch of the XVI-XVII century, which is when the final edition of the Biblical books was taking place. One gets the following idea. Could the famous reference to the stopped sun in the book of Joshua (10:12-14) be a poetic reflection of the deep impression made on the people of the late XVI – early XVII century by the heliocentric cosmology? They finally realised that the Sun can be stopped – contrary to the obvious, since it always moves across the sky and never stops. It could be for an ulterior reason that the stopping of the Sun was ascribed to none other but Joshua, Son of Nun (see CHRON6). In our reconstruction, he is the conqueror of the XV-XVI century, the epoch of the Ottoman conquest of the "Promised Land". The idea of a heliocentric system came into being in the XVI century. As we have seen, it was formulated fully in the work of Tycho Brahe. An ancient drawing of his system can be seen in fig. 11.37.

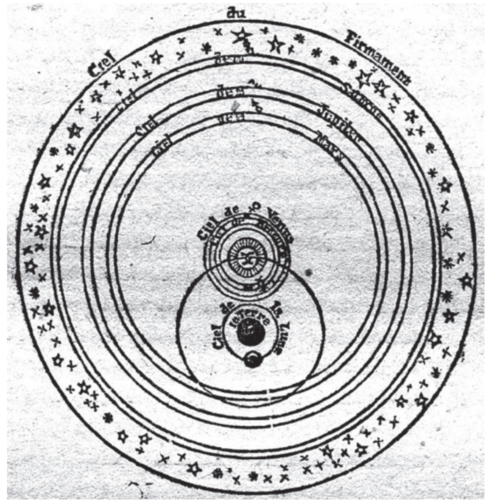


Fig. 11.37. Ancient cosmological scheme according to Tycho Brahe, which is the heliocentric system with the initial reference point affixed to the Earth. Taken from [946], page 151.

It is remarkable that the vestiges of the discussion concerning the Biblical stopped Sun as held by the astronomers and the ecclesiastical authorities of the XVI-XVI century should reach our time in relation to the Copernican system. The following, allegedly negative, remark made by Luther about Copernicus, is usually recollected in this respect: "The fool wants

to turn the whole art of astronomy upside down – but isn't it stated in the Holy Writ that the Lord asked the Sun to stop, and not the Earth?" (quoting in accordance with [926], page 61). However, we must take a second look at this phrase (ascribed to Luther today). If we are to remove the word "fool" from the above phrase, there will be absolutely nothing negative about it. Moreover, it clearly states that the Sun was stopped, and not the Earth – a de facto confirmation of what Tycho Brahe and Copernicus claimed necessary: to stop the Sun and not the Earth. In other words, one has to place the Sun at the immobile centre of the world. Since we already know that some of the texts ascribed to Luther today date from the XIX century, it may very well be that the Scaligerian editors of the XIX century have introduced a single word ("fool") in order to replace the positive opinion held by Luther of the heliocentric system by a negative one. Of course, nowadays we are told that Luther regarded the Biblical passage in question as a confirmation of the Earth's immobility – and yet we see that the interpretation that confirms the Copernicus concept is also perfectly legitimate.

Let us sum up. There is a possibility that the Biblical book of Joshua reflects the heliocentric cosmology discovered by Tycho Brahe at the end of the XVI century A.D.

8. ANNA COMNENA CONSIDERS PTOLEMY HER CONTEMPORARY. In other words, Ptolemy couldn't have lived earlier than the XII century A.D.

Given our dating of Ptolemy's star catalogue, one might well enquire about how the ancient authors dated the Ptolemaic epoch. Let us turn to "Alexiad", a famous work of Anna Comnena ([418]), allegedly an author of the XII century and the daughter of Alexis Comnene, Emperor of Byzantium. Of course, only a very late edition of this book has reached our day – one of the XVII-XVIII century. Nevertheless, this book appears to have preserved important data about the history of astronomy, which concur well with our reconstruction. They were pointed out to us by V. A. Ivanov. Let us also emphasise that Anna Comnena is considered one of the most informed and best educated mediaeval authors, which makes the evidence she provides all the more valuable.

Thus, Anna Comnena writes the following about astronomy and astrological predictions: "Let me … mention predictions in brief. It is but a new invention – no such science existed in antiquity. Predictions weren't known in the time of the most learned astronomer Eudoxus; Plato knew nothing about them, either, and even the astrologer Manethon knew nothing of this science. When they foretold something, they didn't know how to make a horoscope, establish the centres, observe the disposition of constellations and the rest of the knowledge that the inventor of this method passed on to the generations to follow" ([418], page 186).

These words of Anna Comnena leave no shadow of a doubt about the fact that such concepts as the horoscope (or the distribution of planets among the constellations), constellations themselves as well as centres (apparently, the poles of the celestial sphere) only appeared in her epoch – the XII century A.D., according to Scaligerian chronology. In particular, Anna Comnena claims that the ancient astronomers (Eudoxus and Manethon) knew nothing of constellations, although the Scaligerian history of astronomy tries to convince us that the division of the celestial sphere into constellations was widely used in the "ancient" Greece, qv above.

In CHRON7, Chapter 16, we shall consider the meaning of the mediaeval constellation symbolism and demonstrate that it was conceived in the XI-XVI century – even its earliest elements cannot predate the epoch of Christ, or the XII century A.D. This explains the claim of Anna Comnena perfectly well.

Furthermore, one wonders why Anna Comnena neither mentions Ptolemy, nor Hipparchus, while referring to the astronomers she considers ancient. These names are absent from the index of the "Alexiad" in its modern academic edition ([418]). Yet she does mention Eudoxus and Manethon. And yet we are told that in the epoch of Anna Comnena Ptolemy's Almagest had remained the primary astronomical work for a whole millennium (created in the alleged II century A.D.) Therefore, Anna Comnena should have mentioned it first and foremost when referring to astronomy.

Yet if we read on, we shall be surprised to discover

that Anna Comnena does actually mention Ptolemy, but as a contemporary of hers, no less. This is what she writes about the time of her father – Alexis Comnene: "That was the time … when the famous Egyptian from Alexandrian generously shared the secrets of astrology with everyone. Answering numerous questions, this Alexandrian was very precise in his predictions of the future, and did not even use the astrolabe in some cases … The Alexandrian's successful prophecies were based on the art of logical thinking. The autocrat saw the young people, who believed the Alexandrian to be a prophet of some sort, congregate around him. Twice he addressed him with questions, and both times the Alexandrian provided him with satisfactory replies. Alexis … designated Rhaedesto as the Alexandrian's residence, showed great care and generously provided everything necessary at the expense of the treasury" ([418], page 186).

In general, a whole page of Anna Comnena's book is concerned with the famed Alexandrian – however, mysteriously enough, his name isn't mentioned anywhere once. On the other hand, the names of all the other astronomers and astrologers are faithfully reproduced in Anna Comnena's book ([418], pages 186-187), although she says a great deal less about them.

However, history knows of just one famous Alexandrian astronomer, namely, Ptolemy of Alexandria, who is most likely to be the character referred to by Anna Comnena. The rather odd absence of his name from the pages of her book is highly conspicuous – apparently, the XVII century editors simply erased the famous name of Ptolemy from the pages of the "Alexiad". After all, in the XVII century, when this work was brought into correspondence with Scaligerian chronology, Ptolemy was sent to the II century A.D., and the lifetime of Anna Comnena was dated to the XII century A.D., which resulted in an arbitrary millenarian gap between the two. Historians were forced to make corrections in the text of the Alexiad so as to prevent unnecessary questions. Nevertheless, it is perfectly easy to identify the nameless Alexandrian as Ptolemy.

The compilation of a star catalogue was too great a task for a single scientist, no matter how talented – it required state support, instruments, helpers, and, finally, money – a lot of it. Indeed, Anna Comnena reports that the all of the above was provided by the Emperor himself.

The mysterious observation spot Rhedesto, mentioned but once in the entire work of Anna Comnena, qv in the index ([418], page 682) is most likely to identify as the famed Isle of Rhodes, apparently considered a convenient astronomical observation location. According to our hypothesis, in the XVI century the "ancient" Hipparchus = Tycho Brahe performed his observations there as well. At any rate, the Isle of Rhodes is frequently mentioned as a place of astronomical observations – in Ptolemy's Almagest, for one.

9. OBVIOUS DATING OF THE PTOLEMAIC EPOCH ON PTOLEMY'S PORTRAIT IN THE OLD GERMAN "GLOBAL CHRONICLES" BY HARTMANN SCHEDEL

Let us turn to a well-known mediaeval book of Hartmann Schedel, which is dated to the XV century ([1396:1]). It is known as "The Book of Chronicles with Figures and Illustration, from Genesis to Our Days" ([90], page 23). It is also known as "The Nuremberg Chronicle" or "The Augsburg Chronicle". It is believed to have been "the first illustrated encyclopaedia of world history and geography ever" ([90], page 23).

"His 'Global Chronicle' was compiled from Biblical stories, the reports of the ancient historians (Herodotus and Titus Livy for the most part) as well as mediaeval authors, reports of Schedel's contemporaries and his own judgements … The book came out in German and in Latin simultaneously, and was immensely popular … It was sold all across Germany, as well as Vienna, Paris, Graz, Krakow, Lyon and Budapest; it was ordered by customers in Milan, Passau, Lübeck, Ingolstadt, Danzig, Frankfurt and Bamberg. It was sold by the most famous vendors of Venice, Florence and Geneva … The engravings of the 'Augsburg Chronicle' were apparently made by Thomas Burgkmeier (1444? – 1523), an engraver from Augsburg and the father of the famous painter Hans Burgkmeier … The illustrations depict the events of the ancient history and recent times … rulers and philosophers, poets and scientists" ([90], pages 23-24).

Ptolemy's portrait has been included into Schedel's chronicle as well (fig. 11.38). It turns out that this

Fig. 11.38. Ancient drawing of Ptolemy from the ***Global Chronicle*** by Hartmann Schedel. Augsburg, 1497. Taken from [90], page 25.

Fig. 11.39. Ancient drawing of Ptolemy from the ***Global Chronicle.*** A fragment. The chronicle dates from 1497. We see a close-in of the sector where Ptolemy is holding the celestial coordinate grid. The dating we see here reads as 1546 – or, possibly, 1346. In other words, Ptolemy's lifetime is dated to the XIV or even the XVI century A.D. Taken from [90], page 25.

portrait contains a date. Ptolemy is holding a sector with a coordinate grid in his hands (fig. 11.39). Apart from that, we can see a date here: 1346 or 1546, the ambiguity arising from the fact that there is a line right next to the top part of the figure of five, which may be part of a poorly printed letter. If this is the case, the figure of five transforms into a figure of three. The rest of the figures can be read perfectly well – they completely conform to the standards of the epoch, in particular, the figure of four, which looks like the inverted letter gamma. Numerous examples of figures in mediaeval translation can be found in Chron1, Chapter 6:13.

Thus, Ptolemy's lifetime is dated to the XIV or the XVI century here, which is in excellent correspondence with our dating of the Almagest.

We must note that this date very obviously does not refer to the date of the engraving's manufacture. Firstly, it is right on the figure of Ptolemy and not anywhere near it; also, the figures are rather large. Secondly, this date, whatever the interpretation, 1346 or 1546, can by no means refer to the lifetime of the artist, who is presumed to have lived in 1444-1523 ([90], page 24). The year of the artist's birth is accompanied by a question mark, but it changes nothing in this case, since there is nearly a whole century between 1346 and 1444.

It must also be noted that the above date cannot be regarded as numbers grading the instrument in Ptolemy's hands, either, since in this case they would be drawn evenly or separated by equal gaps, which is not the case. The figures transcribe as a mediaeval date, and without any ambiguity whatsoever.

10. THE MEANING OF THE WORD "PELUSIENSIS" (OR "PHELUDIENSIS") IN THE FULL NAME OF PTOLEMY

The title pages of the Almagest's first editions call Ptolemy a philosopher and mathematician from Pelusian (or "Pheludian" in other editions) Alexandria.

For instance, we read the following in the title page of the Latin edition allegedly dating from 1537: "*Cl. Ptolomaei Phelvdiensis Alexandrini Philosophi et Mathematici …*" (see fig. 11.4 above).

The title page of another Latin edition (ascribed to 1551 today) says the following: "*Clavdii Ptolemaei Pelusiensis Alexandrini …*" (see fig. 3.18).

We must pay close attention to the word "Pheludiensis" (or "Pelusiensis") in this title. Different transcriptions of this word must result from confusion in letters – for example, the letter "S" as it is written in the word "Pelusiensis" (fig. 3.18) can be taken for the letter "d" with a missing element. Indeed, in the second version we see the letter "D", namely, "Phelv-Diensis", qv in fig. 11.4.

Apparently, both versions were derived from some word that wasn't too comprehensible to the editors of the above Latin editions (or earlier copyists, whose manuscripts were used in preparation of these editions). What exactly it is that the word in question stands for appears to baffle the modern commentators. Let us quote the commentary from the Russian edition of the Almagest ([704]), for instance: "It is reported that Ptolemy was born in the Hermian [Ger-

Fig. 11.40. The cosmological model of Cosmas Indicopleustes, allegedly dating from the VI century A.D. There is a drawn copy of this old map in CHRON3, Chapter 11, fig. 11.7. The Earth is flat; Mount Ararat rises from its centre, while the Sun and the Moon rotate around the latter. One sees that the author's understanding of astronomy is very rudimentary, reflecting the very low level of scientific development in the epoch of the X-XIII century. Taken from [1177], page 262.

man? – Auth.] Ptolemaeia … according to another version, he was born in Pelusius … which is, however, more likely to be a corruption of the name 'Claudius' as encountered in Arabic sources" ([704], page 431). Therefore, the word "Pelusiensis" (or "Pelusian") is considered to be a corrupted version of some other word by the modern commentators. The exact identity of this word remains a mystery to them.

Let us voice the following assumption in this respect. One must note that a comparison of the above two variants of the mysterious word lead one to the following simple idea. It could be that they are derived from the Slavonic word "*poludennaya*", or southern Alexandria, in other words. This Russian word was then transcribed with Romanic characters as "Peludensis", and later "Pelusiensis", with the first D transforming into S in one of the versions. In the second version, the letter D remained intact, but the P became "PH" (F), which complicated the recognition of the word. A while later, attempts to find out the initial meaning were rendered to pure guesswork.

And yet the word "*poludenniy*" is well known to

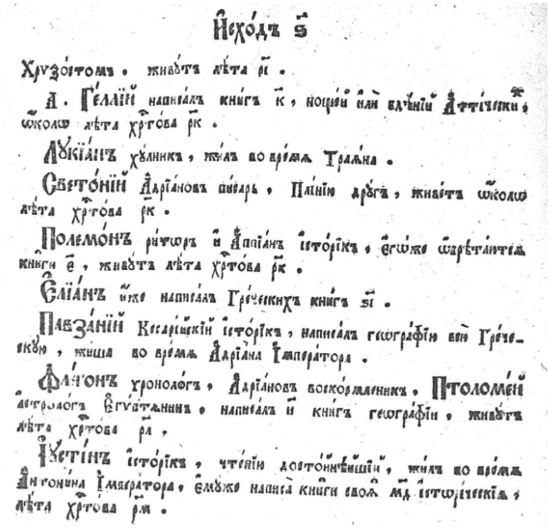
Fig. 11.41. An "ancient" inlay from a synagogue, allegedly dated to the VI century A.D. This inlay (Beth-Alpha, Hefzibah) is presumed to be done in the Byzantine tradition, with Hebraic inscription ([1177]), page 266. We see the Zodiac and the four seasons in the corners. According to historians, what we see in the middle is a solar deity wearing a crown (distinctly Graeco-Roman), with a crescent on his right and with 23 stars around him, and his chariot drawn by four horses. As we can see, one could find zodiacs in the most curious places apart from the "ancient" Egyptian temples – synagogues, for instance. Taken from [1177], Ill. 15.4, page 267.

us from the ancient Russian language, where it stood for "southern". Therefore, "Pelusiensis Alexandria" translates as "Southern Alexandria".

Therefore, it is most likely that the lost manuscripts of the Almagest claimed Ptolemy to be a philosopher and mathematician from Southern Alexandria. This is perfectly natural – Ptolemy was an astronomer who performed many observations, and it is much easier to observe the sky in southern latitudes – more stars are visible there, since there are no fogs and the skies are clear more often.

There were many cities known as "Alexandria" in the Middle Ages, one of them in Russia – the famous Aleksandrovskaya Sloboda near Moscow, a royal residence of the XVI century known as the city of Aleksandrov nowadays (see CHRON6, Chapter 7 for more details). Another city called Alexandria existed in North Italy, as indicated on many mediaeval maps – and so on, and so forth. Therefore, the title page of the Almagest's printed version specified that Ptolemy lived and worked in Southern Alexandria and not any other city named similarly. It might identify as the modern Egyptian city of Alexandria. Alternatively, the XVI century Southern Alexandria of the "Mongolian" Empire could be located much further to the South – in the South of the modern India, for example, where the imperial observatories could be located in the XV-XVI century, with corresponding astronomical observations carried out.

Let us conclude with some auxiliary data of interest – see figs. 11.40-11.42.



Исходъ ѕ

Хрvзостомъ. живѹтъ лѣта рі.

А. Геллїй написалъ книгъ к, нощныи или бдѣнїи Аттическихъ, ѡколо лѣта Хртова рк.

Лѹкїанъ хѹлникъ, жилъ во время Траяна.

Светонїй Адрїановъ писарь, Плинїю дрѹгъ, живѣтъ ѡколо лѣта Хртова рк.

Полемонъ ритѡръ и Аппїанъ историкъ, егѡже ѡпрѣтаются книги е, живѹтъ лѣта Хртова рк.

Еліанъ иже написалъ Греческихъ книгъ ѕі.

Павзанїй Кесарїйскїй историкъ, написалъ географїю всю Греческѹю, живша во время Адрїана Імператора.

Флегонъ хронологъ, Адрїановъ воскормленникъ. Птоломей астрологъ Египтянинъ, написалъ и книгъ географїи, живѹтъ лѣта Хртова рл.

Іѹстинъ историкъ, чтенїю достойнѣйшїй, жилъ во время Антонина Імператора, емѹже написа книги свои мд историческїя, лѣта Хртова рм.

Fig. 11.42. Information about Ptolemy from the Western European *Luteran Chronograph* dating from 1680 (private collection): "Phlegon the chronologist, a creature of Hadrian. Ptolemy the Egyptian, an astrologer. Wrote 8 books on geography; both lived in the 130th year of Christ". This is all that the chronograph in question knows about Ptolemy. One has to note that the actual Almagest isn't mentioned here at all, despite the references to Ptolemy and his ***Geography***. This is odd, if one is to believe the information about several Western European publications of the Almagest that date to the XV-XVI century. Why do we find no mention of the Almagest in a chronograph of the late XVII century? Could it be that the first publications of the Almagest came out near the end of the XVII century, to be eventually dated "backwards" – to the alleged XV-XVI century? Taken from [940], sheet 145, reverse. A photocopy of the original.

Part 2

THE DATING OF THE EGYPTIAN ZODIACS

A. T. Fomenko, T. N. Fomenko, G. V. Nosovskiy

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A foreword to Part 2

The dating of the Egyptian zodiacs is a problem that was studied by many scientists of the XIX-XX century. A large contribution into the solution of this problem was made by N. A. Morozov ([544], Volume 4). However, his analysis of the Egyptian zodiacs is far from final, and the datings he came up with aren't quite satisfactory from the astronomical point of view. This was pointed out in the work of N. S. Kellin and D. V. Denisenko ([376]), who have managed to get a better solution for the Round Zodiac of Dendera than N. A. Morozov. However, they admit it themselves that their solutions are also far from ideal ([376]).

The first one to suggest a strict approach to the selection of astronomical solutions for the Egyptian zodiacs was T. N. Fomenko in [912:3]. This work demonstrated in particular that the Egyptian zodiacs allow for ideally strict solutions in case of certain interpretations of their astronomical content, and perfectly allowable ones at that. However, these interpretations as suggested by [912:3] weren't the only possible ones. Apart from that, many of the graphical details found in the Egyptian zodiacs hadn't yet been deciphered at the time. This goes to say that at this stage of research the problems of ambiguity and incompleteness of the Egyptian zodiacs' astronomical interpretation remained unsolved. Another poignant issue was presented by the fact that the astronomical datings of the Egyptian zodiacs are very unstable in face of variations in source data – in other words, minute and acceptable changes in the interpretation of a zodiac could lead to a significantly different astronomical dating thereof.

All of the above means that the astronomical datings of the Egyptian zodiacs obtained by 2001 could not be regarded as final.

This is why A. T. Fomenko and G. V. Nosovskiy launched a new research in 2000-2001 which included the development of special astronomical software that would make is feasible to run over all possible variants of the zodiacs' astronomical interpretation ([METH3]:4). Practically all of the graphical details found in the Egyptian zodiacs were studied in the process – even the ones that were considered completely unrelated to astronomy previously. It turned out that each of those figures has explicit astronomical meaning. This resulted in the important and unexpected discovery of the fact, that unlike many of the ancient zodiacs, the Egyptian ones contain a great many additional astronomical data apart from the main horoscope. It is important that these data weren't included into the Egyptian horoscopes randomly – they follow a single rigid structure in every case.

What we have therefore discovered is the general

structure of the Egyptian zodiac as a description of a calendar year spanning the primary date represented by a special cipher of sorts.

As a result, the total amount of useful astronomical information contained in a single Egyptian zodiac usually suffices in order to decipher the date it stands for; apart from that, it contains an exhaustive astronomical explanation of its cipher. In other words, our new approach isn't based upon the decipherment of the Egyptian zodiac, but rather allows to accomplish said goal via astronomical calculations, likewise the date of the zodiac.

The datings of the Egyptian zodiacs that we come up with as a result are of a stable nature, and only allow for a single solution in case of the majority of zodiacs.

From the preface to

The New Chronology of Egypt. The Astronomical Datings of Ancient Egyptian Monuments. Research of 2000-2002

by A. T. Fomenko and G. V. Nosovskiy (Moscow, Veche, 2002)

This book is dedicated to the interpretations of datings contained in the ancient Egyptian zodiacs. We set several precise chronological landmarks of Egyptian history here, which was made feasible by our recently-developed method of the complete deciphering of the Egyptian zodiacs.

In our research of the Egyptian zodiacs we have used many important ideas of our predecessors N. A. Morozov ([544], Volume 6), N. S. Kellin and D. V. Denisenko ([376]) as well as T. N. Fomenko ([912:3]). In general, our research can be considered to continue and develop theirs. Many of the doubtless and fundamental facts estimated by these authors in re the astronomical symbols used in Egyptian zodiacs were adhered to and received independent confirmation. Apart from that, we have discovered that there is another layer of astronomical symbols present in the Egyptian zodiacs whose meaning remained beyond our comprehension earlier. This discovery, which came as considerable surprise even to ourselves, brought us to an altogether new level insofar as the opportunities of dating the Egyptian zodiacs are concerned.

Owing to these unique opportunities and extensive astronomical computations we could estimate about ten datings as the only ones possible; all of them were presented in the ancient Egyptian zodiacs with the use of an old "astral calendar". All of the dates fall over the same post-XI centurty epoch.

The previously known interpretations of the Egyptian zodiacs (first and foremost the ones belonging to N. A. Morozov, N. S. Kellin – D. V. Denisenko and T. N. Fomenko were of a partial nature. These authors managed to obtain astronomical identifications of many zodiacal symbols, but not all of them, which is quite understandable since one had to sort out a great many interpretation options, and this is hardly possible to do manually. The interpretation we got in 2001 is the first one which is complete and accounts for all the graphical details of every zodiac; it also turns out that an astronomical solution is available in every case, which is an extremely important fact. The existence of such complete interpretation which can always be dated is very far from obvious a priori. Apart from that, the astronomical solutions that we came up with for the overwhelming majority of the zodiacs turn out to be the only ones. Our analysis is final in this respect.

It turns out that the complete interpretation of the primary horoscopes found in Egyptian zodiacs includes the partial interpretations offered by N. A.

Morozov and T. N. Fomenko; however, there is a certain difference between them details-wise which brings clarity into multiple choice situations such as the interpretation of the symbols used for the sun and the moon that are rather easily confused with one another. Our predecessors would argue in favour of their choice after studying the content of the Egyptian symbols since they had no opportunity of sorting through all possible interpretation options yet, unlike the authors of the present book. Their interpretations weren't final in some cases, which would therefore make the datings they discovered less strict; therefore, the final datings that we came up with differ from the previous datings offered by Morozov, Kellin-Denisenko and T. N. Fomenko. However, all of the precise datings remained mediaeval, which is a rather important fact. It turns out that there isn't a single astronomical solution for the Egyptian zodiacs that would date to an epoch preceding the XII century A.D.

We also feel obliged to point out that the final datings that we managed to calculate for the Dendera zodiacs have already been mentioned in the work of T. N. Fomenko. Namely, she already considered the dating of the 22-27 April 1168 for the Long Zodiac of Dendera in the preliminary stage of her analysis, which coincides with the dating discovered by ourselves. This dating was rejected by T. N. Fomenko due to different identifications of the sun in the interpretation chosen by N. A. Morozov and the one that turned out final according to our method ([912:3], page 721). The same work by T. N. Fomenko ([912:3] specified the date of the 30-31 March 1185 as a possible solution for the Round Zodiac in one of the early analysis stages, which only differs from the final solution dating that we came up with by a mere 10 days. This dating was also rejected by T. N. Fomenko due to minute discrepancies between her interpretation and the final interpretation of the Round Zodiac offered by our method. As is the case with the Long Zodiac of Dendera, these discrepancies concerned the symbols used for the sun and the moon which are easy to confuse for one another.

Let us reiterate that after we had finished our computer calculations it turned out that the previous partial interpretations were confirmed for the most part. They comprise the fundament of the final interpretation, which confirms the general correctness of the previous research. It has to be said that all of the authors who studied the Egyptian zodiacs that we refer to above always emphasised that their datings were based on the interpretation options that struck them as the most likely and not an exhaustive study of all possible variants.

Let us now list our datings of the ancient Egyptian zodiacs based on our final interpretation.

1) *The Round Zodiac of Dendera:* morning of the 20th March 1185 A.D.

2) *The Long Zodiac of Dendera:* 22-26 April 1168 A.D.

3) *The Zodiac from the Greater Temple of Esna:* 31 March – 3 April 1394 A.D.

4) *The Zodiac from the Lesser Temple of Esna:* 6-8 May 1404 A.D.

The Athribis zodiacs of Flinders Petrie:

5) *The Upper Zodiac of Athribis:* 15-16 May 1230 A.D.

6) *The Lower Zodiac of Athribis:* 9-10 February 1268 A.D.

7) *The Theban Zodiac of Heinrich Brugsch* which, as it turned out, contains a total of three zodiacs, each one of which gives an independent dating.

7a) The horoscope of demotic additions – 18 November 1861 A.D. (old style).

7b) The horoscope "without rods" – 6-7 October 1841 A.D. (old style).

7c) The "boat horoscope" – 15 February 1853 A.D. (old style).

Thus, the "ancient" Egyptian wooden coffin whose lid was adorned with this spectacular zodiac was manufactured in the middle of the XIX century.

8) *The coloured zodiac of Thebes* found in the Egyptian "Valley of the Kings" and represented in the Napoleonic Egyptian album ([1100]) – 5-8 September 1182 A.D.

The datings we come up with allow us to make the perfectly valid claim that the "ancient" history of Egypt and its Pharaohs doesn't date back to several millennia before the new era, but rather to the XI-XV century A.D. – a "mere" 400-1000 years ago, in other words. As for the grandiose temples of the ancient Egypt, the Zodiac dates in these temples indicate the epoch of late XII – early XV century A.D.

The dates on the wooden Egyptian coffins (or sarcophagi) are of the utmost interest indeed. These

wooden coffins, painted in different colours and covered in hieroglyphs, can be seen in many art albums on Ancient Egypt. They are considered to be "extremely ancient". However, it turns out that their real age can be estimated precisely in certain cases due to the fact that the lids of these sarcophagi were often adorned with zodiacs containing ciphered dates. Deciphered, one of them (the zodiac of Brugsch) yielded the middle of the XIX century as a result. In other words, the "ancient" Egyptians (or, possibly, the Mamelukes) were making such coffins and used them for burials as recently as 150 years ago. Nowadays they are up on exhibition in many museums as the alleged relics of "ancient" history.

For some strange reason, we are given no explanation of the fact that the smoothly-planed and accurately sawed planks these Egyptian coffins are supposed to have been manufactured in absence of iron tools, likewise the boats of the Pharaohs. The implication is that the "ancient" Egyptians had planes. However, we are being told that the "ancient" Egyptians only had copper at their disposal, which isn't the material one can use for making a plane. What are we left with, then? Another "mystery of the Ancient Egypt"? Such mysteries are abundant in Egyptian history. Now we have a means of eliminating them having the knowledge that the "ancient" Egypt, as well as other "ancient" civilizations are only several centuries old in reality, which is why we often put the word "ancient" in quotation marks.

As we have demonstrated in our previous books on the subject, the consensual version of ancient Egyptian chronology is most likely to be erroneous, which brings us to the question of when this false version first came to existence, as well as the entire erroneous version of Egyptian history that it is based upon.

It turns out that its roots don't reach further back than the end of the XVIII century which is when the Europeans got their first opportunity of travelling to Egypt after several centuries of isolation. The Napoleonic army disembarked on the Egyptian shore in 1799; this was followed by the defeat of the Mamelukes in the famous Battle of the Pyramids. This is when the Europeans made their first acquaintance of the Egyptian antiquities, and the European scientists drew up a more or less detailed picture of ancient Egyptian history.

Shortly afterwards the "Napoleonic" album with drawings of the Egyptian monuments was published in France ([1100]). It included detailed drawings of several Egyptian zodiacs, among other things. This album was the first illustration of what relics were found in Egypt, since the Europeans only had a vague idea of the land itself as well as its history prior to that. In order to provide the reader with a demonstrative example of just how meagre the European knowledge of Egyptian history had been as recently as the XVII century we provide the entire section on Egyptian history taken from a voluminous and fundamental chronograph dating to the end of the XVII century in [METH3]:4, Chapter 9. This section in its entirety takes up a mere two pages and contains nothing remotely resembling the modern version of Egyptian history which came to existence somewhat later (see ibid).

In school we are told the impressive tale of how Champollion who accompanied the Napoleonic troops to Egypt managed to decipher the mysterious hieroglyphs which had remained beyond everyone's comprehension for several centuries. It turns out that "the last stage the Egyptian language reached in its development had been the Coptic language of the Christian population of Egypt ... it was supplanted by the Arabic around the XVII century" ([85], Volume 15, page 464). In other words, the "ancient" Egyptian language in the final stage of its development had been the spoken language of the Egyptian Christians up until the XVII century A.D., no less! It becomes clear why Champollion would have to study the Coptic language in order to decipher the hieroglyphs ([85], Volume 47, page 510).

It is presumed that the labours of Champollion and his contemporaries, the founders of Egyptology, enabled the Europeans to glance into the very depths of the Egyptian history of the Pharaohs, which they were a priori ready to consider "exceptionally ancient".

Even though the deepest antiquity of the Egypt ruled by the Pharaohs was considered obvious, exact datings had remained unknown, and there was much diversity in opinions on how certain events of Egyptian history were to be dated. For instance, there were supporters of the "long" and the "short" version of Egyptian chronology amongst the Egyptologists; the discrepancy between the two versions amounted to

several thousand years ([METH1]). The datings suggested by the specialist for the dating of Egyptian monuments could differ by several millennia or even several dozen millennia. Thus, for instance, the "Egyptologist" dating of the famous Dendera zodiacs which we shall be considering in the present book, had altered by a whole 15.000 years ([544], Volume 6, page 651).

Egyptologists were making claims about the "indubitable antiquity" of Egyptian history from the very beginning, and they are still very much at it. However, there is no real evidence to support this allegedly "self-implied" antiquity. The "reasons" they suggest as validation of this theory don't hold up to serious criticisms and are based on absolute certainty that the history of the Pharaohs pertains to an antediluvian age and had ended before the beginning of the new era (see [METH1]).

We shall refrain from reiterating our criticisms of the consensual Egyptian chronology and the radiocarbon datings of the Egyptian specimens in particular, since a detailed rendition of those can be found in CHRON1 and CHRON2 by A. T. Fomenko.

Let us briefly formulate the hypothesis that is related in detail in CHRON5.

We are of the opinion that the ancient Egypt in the times of the Pharaohs had been the royal burial ground of the Great Empire in the Middle Ages. This Empire had spanned all of Eurasia and a large part of Africa in the epoch of the XIV-XVI century A.D. Egypt had been a small part of this Empire, although it may have been the birthplace of its royal dynasty. The necropolis of the royal family was located in Egypt, and the population of this country was employed as workers and keepers of this cemetery. The kings, or the Pharaohs, did not live in Egypt and were brought here post-mortem. We consider this to be the explanation of the odd fact that almost all of the "ancient" Egyptian inscriptions contain nothing but descriptions of funeral rites.

Therefore, according to our reconstruction, the ancient Egypt had been the cemetery for the kings of the Great mediaeval Empire, and its inhabitants had to guard the peace of their deceased rulers, which had been their primary task. This was naturally done at the expense of the vast Imperial resources and not locally.

In CHRON5 we also consider the issue of the construction of the pyramids. Egyptologists present us with rather spectacular yet absolutely ephemeral pictures of how the pyramids and other colossal stone constructions of the ancient Egypt were built. We are told about the great masses of "ancient Egyptian slaves" who were supposed to cut gigantic blocks of stone weighing some 200-500 tonnes from mountain quarries using copper saws, no less. These monstrous blocks would then be towed across the sand and transported over the Nile in some mysterious manner. Finally, they would be used as bricks for the construction of the pyramids.

None of the above is likely to have taken place. The construction of the pyramids must have been a much more interesting and realistic endeavour as opposed to the rather odd version related above.

According to the new point of view, the technologies of the XIV-XVI century were used in the Ancient Egypt, and rather complex ones, at that. Many of them were lost for many centuries after the decline of the Empire in the XVII century, such as the geopolymer concrete (see [REC]:2). The secret of this concrete was re-discovered several decades ago by Joseph Davidovich, the French chemist. It is widely used in construction nowadays, qv in [1086] – [1093].

Let us conclude with the sentiment that one needn't think that the Egyptian history ceases to be "ancient" in the light of the New Chronology, since the latter shifts the history of all other countries forwards as well, and considerably so. Egyptian history turns out to be the most ancient of all as a result; however, the very definition of the "antiquity" changes due to its former misinterpretation resulting from the use of the Scaligerian chronology.

According to the New Chronology, the oldest events whose traces remain in written history date to the X-XIII century of the new era. The subsequent events of the XIV-XV century are ancient enough, and we only have rather vague information about that epoch.

The ancient epoch ends with the introduction of Christianity in the XV century, which also differs from the historical version of Scaliger a great deal since it had really been a reform of the existing Christian church; however, this reform was significant

enough for the subsequent version of Christianity to have received the definition of a new religion.

This epoch was followed by the Ottoman conquest of the XV-XVI century, when the colonization of America took place, for instance. The decline of the Great Empire took place after this, in the beginning of the XVII century. The historical period to follow can be considered recent history. See CHRON6 and Chron7 for more details.

Let us reiterate that in this chronological framework ancient Egyptian history of the X-XVI century remains one of the oldest; however, there is nothing peculiar about the fact that some of the "oldest" Egyptian customs had existed until the middle of the XIX century.

* * *

We would like to express our profound gratitude to Professor V. Kravtsevich (Alberta University, Canada) and Professor Y. V. Tatarinov (Moscow State University) for their assistance with the search of materials. We would also like to thank Professor V. Kravtsevich for our interesting and useful conversations.

A. T. Fomenko
G. V. Nosovskiy

CHAPTER 12

The Egyptian zodiacs

1. THE EGYPTIAN ZODIACS AND THE LIKELIHOOD OF THEIR RELIABLE ASTRONOMICAL DATING

An Egyptian zodiac is a drawing with a symbolical representation of the celestial sphere. Such a zodiac is done in a distinctive "ancient" Egyptian style and possesses a number of special characteristics that will be discussed below. The very name "zodiac" reflects the fact that the primary attention on these Egyptian drawings is focussed on the zodiacal part of the sky, or the belt of the twelve zodiacal constellations (Aries, Taurus, Gemini etc).

Let us remind the reader that all the planets as well as the Moon move along the zodiacal belt, and that the Sun is always located within the belt. It is naturally impossible to observe the Sun and the stars simultaneously, since the latter cannot be seen during the day. Nevertheless, the position of the sun among the stars is easy to guess at dust or at dawn, when one sees the bright stars at sunrise.

Thus, the Zodiacal belt is the stellar track set by the motion of all the planets, likewise the Sun and the Moon, as seen from the Earth. This fact is of exceptional importance in our case. It was known rather well to the ancient astronomers who had used it for the creation of a rather special kind of "celestial astral clock", where the Zodiacal belt played the role of the dial, and planets served as hands. This very "astral clock" was used for recording dates in Egyptian zodiacs.

It was done in the following manner: the positions of planets as well as the Sun and the Moon would be symbolically drawn on the zodiacs, fixing the positions of planets in relation to the constellations. Bear in mind that this disposition is in fact a horoscope, which is an "astral" representation of a dating. It turns out that if an Egyptian zodiac should contain symbols or planetary names, they serve to record a date transcribed as a horoscope.

Planetary positions on the celestial sphere change rather rapidly; therefore, a horoscope is very soon replaced by another one. Recurrences do take place, but intervals between them usually equal centuries or even millennia.

Modern calculation facilities allow to convert a horoscope into a date on the modern chronological scale with sufficient ease. However, the answer might prove rather ambiguous due to the fact that, very occasionally, a horoscope might recur; however, for most of them such recurrences are a scarce enough event in order to give us the opportunity to date them reliably on the interval of the last 2 or 3 millennia.

We shall give you a detailed account of how the Egyptian zodiacs are dated below. So far let us merely reiterate that Egyptian zodiacs are in no way a mere embellishment; they represent a certain date transcribed as certain symbols. Nowadays deciphering the astronomical symbols of Egyptian zodiacs makes it feasible for us to learn the real time of their compilation, which, in turn, makes it possible to answer the question of when the "ancient" Egyptians could

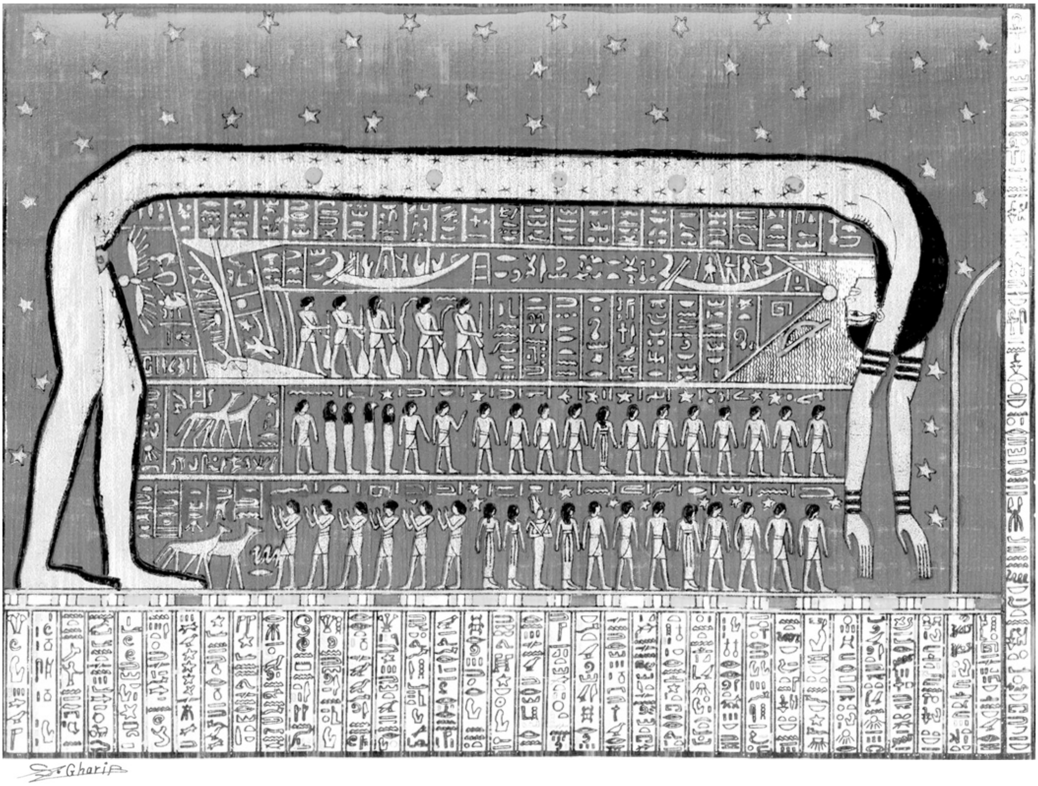

Fig. 12.1. A papyrus with a copy of an ancient Egyptian zodiac purchased in Egypt in the year 2000. Below we see the signature of the modern artist who had made the copy of the zodiac. The original is most likely to be located in one of the tombs from the royal necropolis in Luxor. This zodiac is very popular, and many of its versions, coloured in every which way, are sold in Egyptian papyrus shops. One can also find it on postcards, qv in [623:1]. We instantly see a feature that characterises Egyptian zodiacs – the curved figure of the goddess Nuit ([2], page 10; also [370], pages 14-15).

really have lived and built their "ancient" temples. In other words, the astronomical dating of the Egyptian zodiacs allows the assessment of reliable and scientifically validated reference points in the chronology of ancient Egypt.

We shall jump ahead and mention that all these reference points prove to be mediaeval. Most of these "ancient" Egyptian zodiacal datings postdate the XII century A.D. This concurs well with the new chronology, according to which the earliest dates of written history of humankind date from the epoch of the XI century A.D. the earliest.

Apparently, the zodiacal transcription of dates used to be very popular in Egypt. Even in our day, "ancient" zodiacs are very popular there, and any tourist who might visit Egypt will be offered countless papyri of modern manufacture in memorabilia shops, with multicolour copies of "ancient" Egyptian artwork that will invariably have several zodiacs in their midst. One of such zodiacs (purchased in Luxor in 2000) can be seen in fig. 12.1.

The most well-established Egyptian papyrus shops will be overjoyed to make an "ancient" Egyptian zodiac for a client with the horoscope of the latter's birthday, for instance, or any other arbitrary date. Nowadays this requires no sky observations – all one needs is a computer and some astronomical software that will instantly draw the star chart for any given day; then the data in question are transferred to the papyrus as "ancient" Egyptian symbols, and the horoscope is ready.

It is possible that some of the "ancient" Egyptian

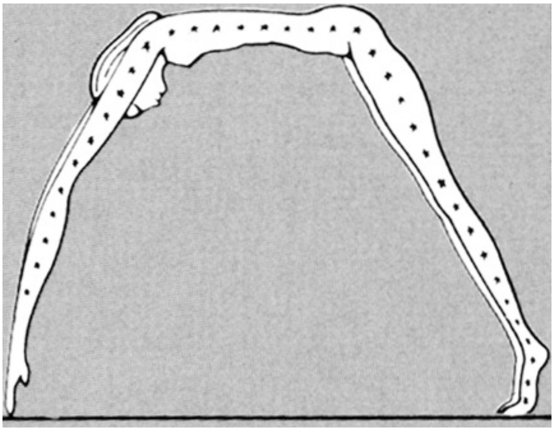

Fig. 12.2. Nuit, the "ancient" Egyptian goddess of the sky. She symbolises the celestial sphere in the zodiacs. We almost always find Nuit drawn as part of the rectangular Egyptian zodiacs, whereas in the round ones she is either drawn separately, near the zodiac, or altogether omitted. Taken from [2], page 10.

zodiacs were manufactured in the XIX or XVIII century and not the antiquity. Zodiacs may have still been part of a living tradition among certain strata of Egyptian society at the time, especially considering as to how they bore direct relation to funeral rites, as we shall see below, and funeral rites are known for their particular longevity. Apart from that, zodiacs could be produced in the XIX century as forgeries for rich European buyers, which is a possibility that one should not neglect. Therefore once we set about dating some mind-bogglingly "ancient" Egyptian zodiac copied from a "doubtlessly exceptionally old" Egyptian sepulchre, we should be prepared to come up with any date – for instance, it may contain a ciphered XIX century dating. This is very much a possibility since the modern archaeological methods of dating "ancient" Egyptian artefacts are unfounded – and, most likely, blatantly incorrect. Egyptian tombs dated to times immemorial might be very recent in some of the cases and even date to the XIX century. We shall run into several such occasions below.

The astronomical meaning of the symbols used in Egyptian zodiacs isn't always obvious. In some cases it only surfaces after a careful study. However, as a rule, Egyptian zodiacs can instantly be told apart from other "ancient" Egyptian artwork by the following distinctive characteristic. In nearly every case they contain the symbol of the celestial sphere drawn as a woman with her arms lifted above her head. This woman often has an unnaturally extended body that spans the zodiac. It is presumed that she represents the Egyptian goddess Nuit, or the "celestial goddess – ([2], page 10; also [370], pages 14-15). See fig. 12.2.

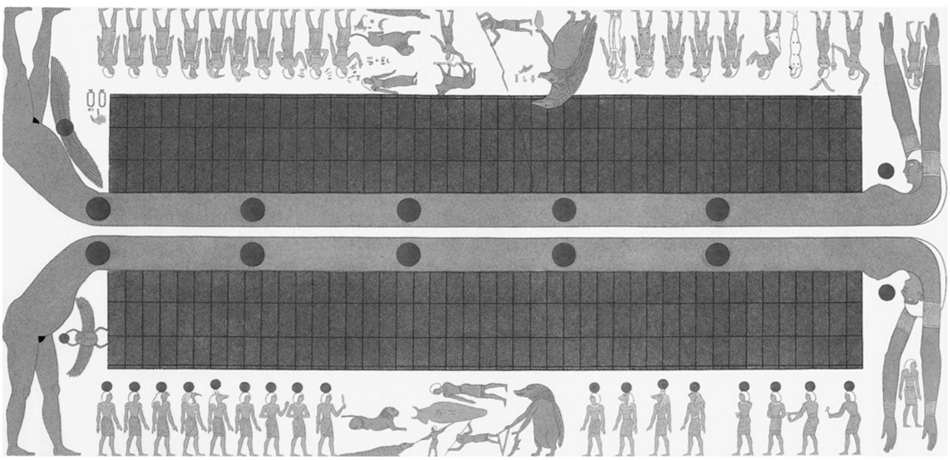

Fig. 12.3. The Theban zodiac "OU" discovered in the Luxor Valley of the Kings, also known as "the royal tomb valley of Biban-el-Muluk" ([2], page 76). This zodiac was found by the Europeans in the early XIX century, during the Napoleonic Egyptian expedition. The coloured version of this zodiac can be found in the Napoleonic album on Egypt ([1100]), accompanied by the following inscription in French: "*Tableau astronomique peint au plafond du 1er tombeau des Rois à l'Ouest*" ("*Astronomical picture painted on the ceiling of the first tomb of the Oriental Kings*"). Taken from [1100], Plate 82.

One can see a picture of Nuit from the papyrus zodiac cited above in fig. 12.1.

Let us cite a few more examples of Egyptian zodiacs. We shall provide a more detailed study of all Egyptian zodiacs below, as well as the symbols upon them. So far we would like to give the reader a general idea of how an Egyptian zodiac might look.

In fig. 12.3 one sees an ancient drawing of the zodiac found in one of the royal sepulchres from the "Theban" necropolis in Luxor. The drawing dates back to the epoch of Napoleon's Egyptian expedition. In general, this zodiac is done in the same style as the papyrus zodiac that one sees above; however, we see the figure of Nuit divided in two. As we shall see from a series of examples, this means that the zodiacal belt is split in two halves. One sees two respective rows of figures upon the zodiac, one under the other, qv in fig. 12.3. Our calculations demonstrate the date ciphered in this zodiac to be the 5-8 September 1182 A.D.

In fig. 12.4 we see a fragment of a ceiling relief carved in stone, depicting a zodiac with the size of 2.55 × 2.53 metres from the Egyptian temple of Dendera. This is one of the most famous Egyptian zodiacs also known as the "Round Zodiac of Dendera" due to its shape and in order to differentiate between it and the "Long" or "Rectangular" Zodiac of Dendera, which was found in the same temple. The round zodiac of Dendera was discovered by the Europeans in 1799 during the Napoleonic expedition ([1062], page 5) and later taken away to Paris ([1062], page 5; also [544], Volume 6, page 651). The original of this zodiac is kept in the Louvre nowadays ([1062], page 6), and there's a copy in the actual temple. A drawn copy of the entire Round Zodiac as well as the surrounding artwork can be seen in fig. 12.5. A photograph of the zodiac's central part can be seen in fig. 12.6, and that of Nuit the goddess from the same zodiac – in fig. 12.7.

In fig. 12.8 one sees a drawing of the Round Zodiac from the Napoleonic Egyptian album. The copy is a very accurate one; however, the artwork is modified to some extent – the original looks a great deal rougher. A modern drawn copy of the Round Zodiac can be seen in fig. 12.9. In order to give the reader a better idea of what it really looks like, we also cite a magnified fragment of the Napoleonic draft of the Round Zodiac in fig. 12.10.

Fig. 12.4. The Round Zodiac DR from the temple of Dendera – a ceiling relief carved in stone, 2.55 by 2.53 metres in size ([1177], page 121). It was taken away to France during the Napoleonic expedition, and is kept in the Louvre nowadays. What one sees in the actual temple of Dendera is a copy. Photograph made in the Louvre, 2000.

Once again we encounter Nuit as the symbol of the celestial sphere, with both a front and a side view available (see figs. 12.5 and 12.8). However, in this case Nuit isn't part of the Zodiacal composition, but rather depicted separately nearby.

One can easily recognize the symbols of all twelve zodiacal constellations upon the Round Zodiac of Dendera (see fig. 12.9). All the zodiacal constellations are drawn in the exact same way as one sees them in the mediaeval European books on astronomy (Leo as a lion, Sagittarius as a centaur holding a bow, Capricorn as a fable-like animal with the head of a goat and the tail of a fish etc). N. A. Morozov, who had given this zodiac a scrupulous study, wrote the following: "I would like to draw the reader's attention to the fact that … the Zodiacal constellations … are drawn perfectly well and comprise the ecliptic belt the way it is situated above the horizon – it is not concentric … to the equinoctial, but rather raised high above it in its summer constellation part with Cancer and Gemini, and below in the opposite part with the winter constellations of Sagittarius and Capricorn. The zodiac resembles the kind one sees on the astronomical maps of Beyer and even in XIX century works on astronomy" ([544], Volume 6, page 658). As we can see, the author of the Round Zodiac had a good knowledge of astronomy, since the zodiac itself is filled with as-

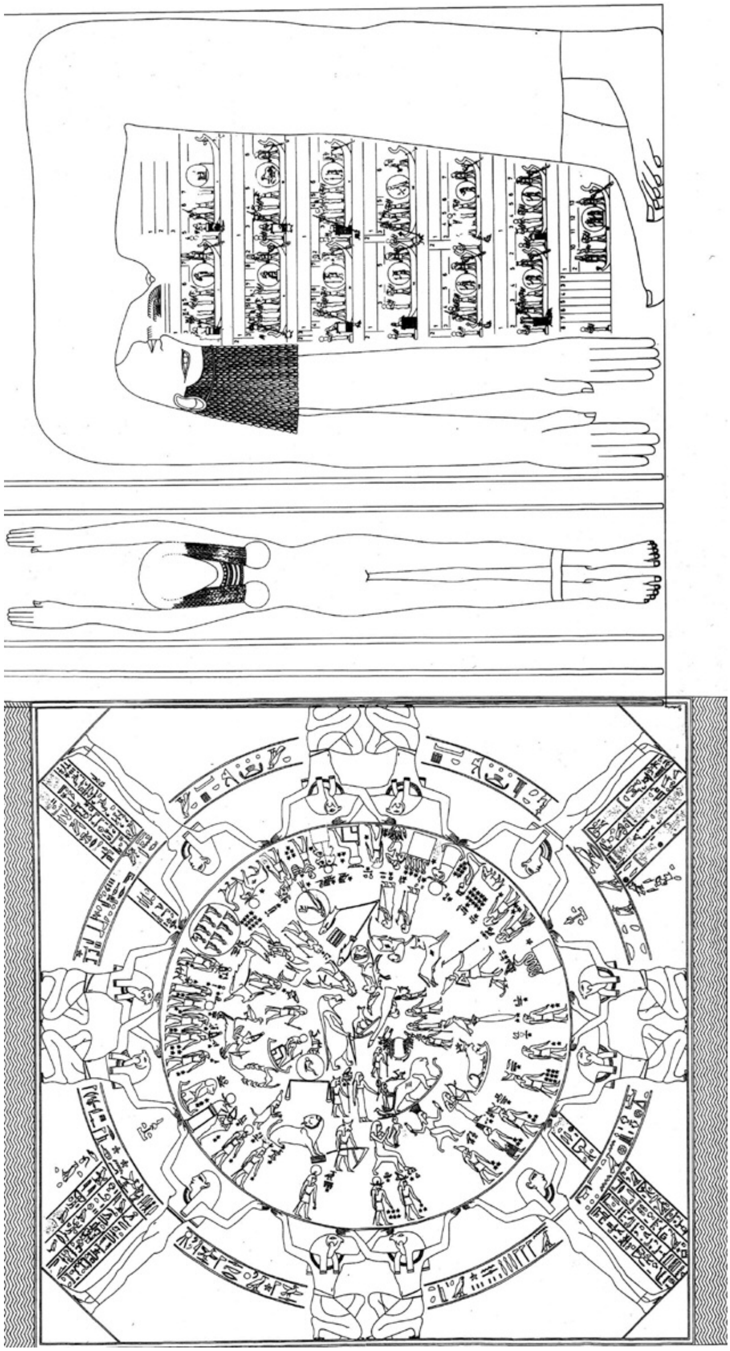

Fig. 12.5. Drawn copy of the Round Zodiac from Dendera (DR), as well as the artwork found alongside the zodiac in the temple. Here we see two symbols of the celestial dome at once represented by the two drawings of the goddess Nuit, which appears to be hanging right over the observer on the right-hand side of the zodiac. The curve of her body cannot be seen in this projection, but must be implied. Nearby we see a "side view" of her figure – just the same as it is in the previous zodiacs. Taken from [1062], page 71.

Fig. 12.6. A photograph of the Round Zodiac's central part (zodiac DR). It is currently kept in the Louvre, France. Taken from [1101], page 255.

Fig. 12.7. The "goddess Nuit", a celestial symbol from the Round Zodiac of Dendera (DR). Modern photograph. Taken from [370], page 165.

tronomical symbols of all sorts – virtually every symbol we see there has some astronomical meaning.

Another zodiac was discovered in the very same Dendera Temple – the "Long" or the "Rectangular" Zodiac of Dendera. Just like the Round Zodiac, it is a ceiling relief of a formidable size consisting of two halves. Each of those equals 25 metres (see figs. 12.11, 12.12, 12.13 and 12.14. Halves of the Long Zodiac that represent the Zodiacal belt between the two of them are located near the ceiling edges of a gigantic "hypostyle" hall (25 by 42.5 metres – see [370], page 162). The ceiling is covered by artwork that is predominantly astronomical in character and content (see fig. 12.15).

A modern photograph of a fragment of the Long Zodiac of Dendera can be seen in fig. 12.16.

The decipherment and dating of the Round and the Long Zodiacs was contemplated in a great number of works. In the XIX-XX century they were studied by Dupuis, Laplace, Fourier, Letronc, Holm, Bio, Brugsch, B. A. Tourayev, N. A. Morozov ([544], Volume 6, pages 655-672), N. S. Kellin and D. V. Denisenko ([376]), and also T. N. Fomenko ([912:3]). As a result, many various and, basically, equally arbitrary datings came to existence. The dating of these zodiacs thus remained ambiguous.

Our research demonstrates that apart from the primary horoscope, the Dendera zodiacs contain auxiliary astronomical information which wasn't taken into account by previous researchers. Once the oversight is rectified, we come up with an absolute dating – namely, the horoscope of the Round Zodiac of Dendera can be dated to the morning of the 20th March 1185 A.D., according to our research. The horoscope of the Long Zodiac can be dated to the 22-26 April 1168 A.D., or 17 years earlier. See more about these datings in CHRON3, Chapter 17.

Thus, we learn that the ancient Egyptian temple in Dendera was built in 1185 the earliest; most possibly – a great deal later.

Indeed, the date that we find ciphered on the ceiling of the temple can hardly correspond to the time

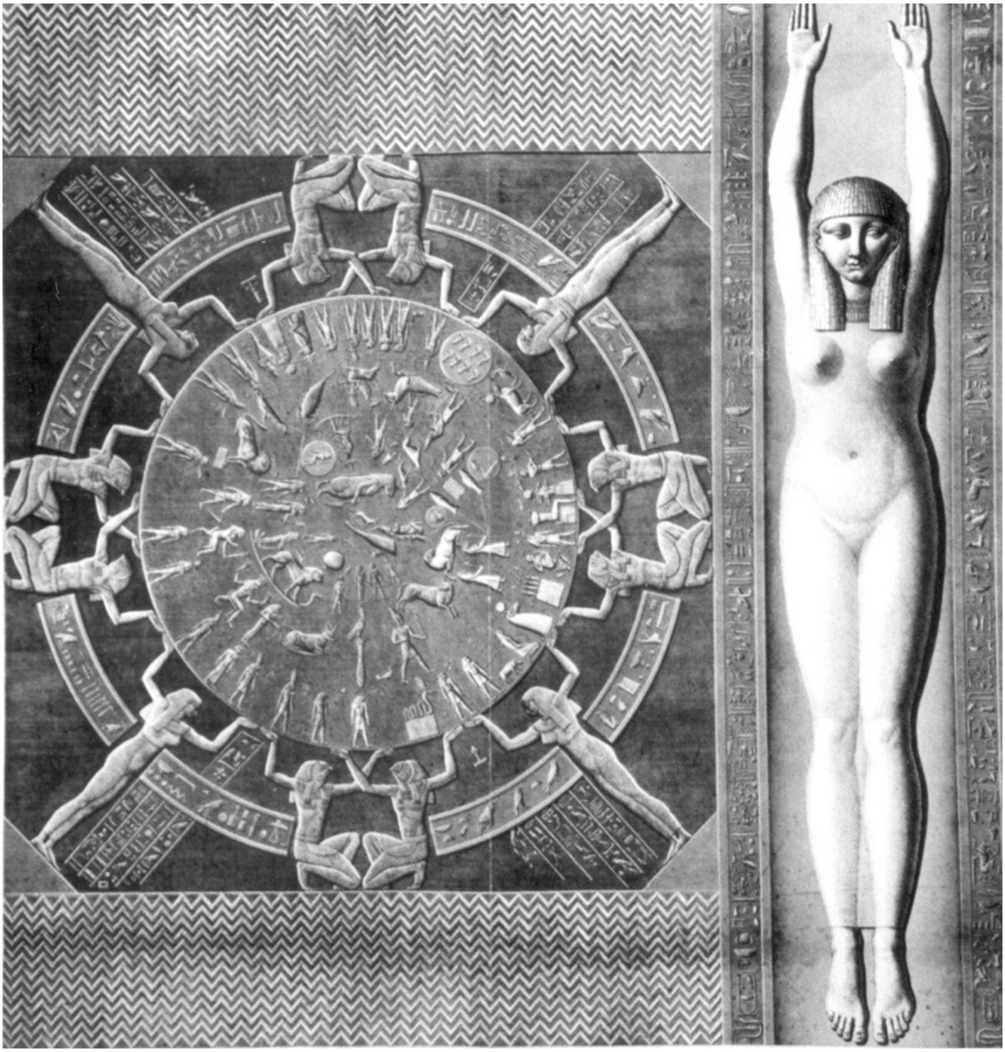

Fig. 12.8. A picture of the Round Zodiac (DR) together with one of the nearby figures of the celestial goddess Nuit. Taken from the Napoleonic album on Egypt dating from the early XIX century ([1100], A. Vol. IV, Pl. 21).

of the temple's creation; it is more likely that the builders of the temple adorned its ceiling with the date of some holy event – the one that the actual temple was consecrated to, for instance. According to the New Chronology, the holy place of Dendera that comprises the hypostyle hall with the Long zodiac, as well as the chamber with the Round one, must have been built around the XIV-XV century A.D., which had been the epoch between the Great = "Mongolian" conquest of the XIV century and the Ottoman = Ataman conquest of the XV-XVI century, or, alternatively, the second half of the XVIII century when the Mamelukes seized power in Egypt once again, albeit for a short while. In other words, these constructions must have been erected by the Mamelukes.

Let us remind the reader that Egypt was conquered by the Ottomans (Atamans) in 1517, and that the Mamelukes had ruled there earlier ([85], Volume 15, page 454). According to our reconstruction, it was the Mamelukes that maintained the influence of the

Fig. 12.9. A drawn copy of the Round Zodiac of Dendera. Our comparison with the photograph demonstrates this copy to be very precise. It is possible that it was made after a photograph. Taken from [1062], page 71.

Great = "Mongonian" Empire in Egypt. Their objective was to look after and to protect the grandiose royal cemetery of the Great Empire. This cemetery probably comprised the pyramids, the temples and other constructions related to the royal funeral rites in some way, qv in Chron5.

In 1517 the Mamelukes lost power in Egypt to the Ottomans (Atamans). Although our reconstruction implies both Ottomans (Atamans) and Mamelukes to have originated from Russia-Horde, the epoch of the Ottoman conquest made a great many old customs and traditions of the Great = "Mongolian" Empire change to a great extent. These changes resulted from great embroilment, possibly accompanied by drastic dynastic changes in the XV century Empire, qv in Chron5. Therefore, the Ottomans (Atamans) could have persecuted certain old traditions of the Great Empire, destroying the "heretical" old temples and building new ones after a new fashion.

However, 250 years after the Ottoman (Ataman)

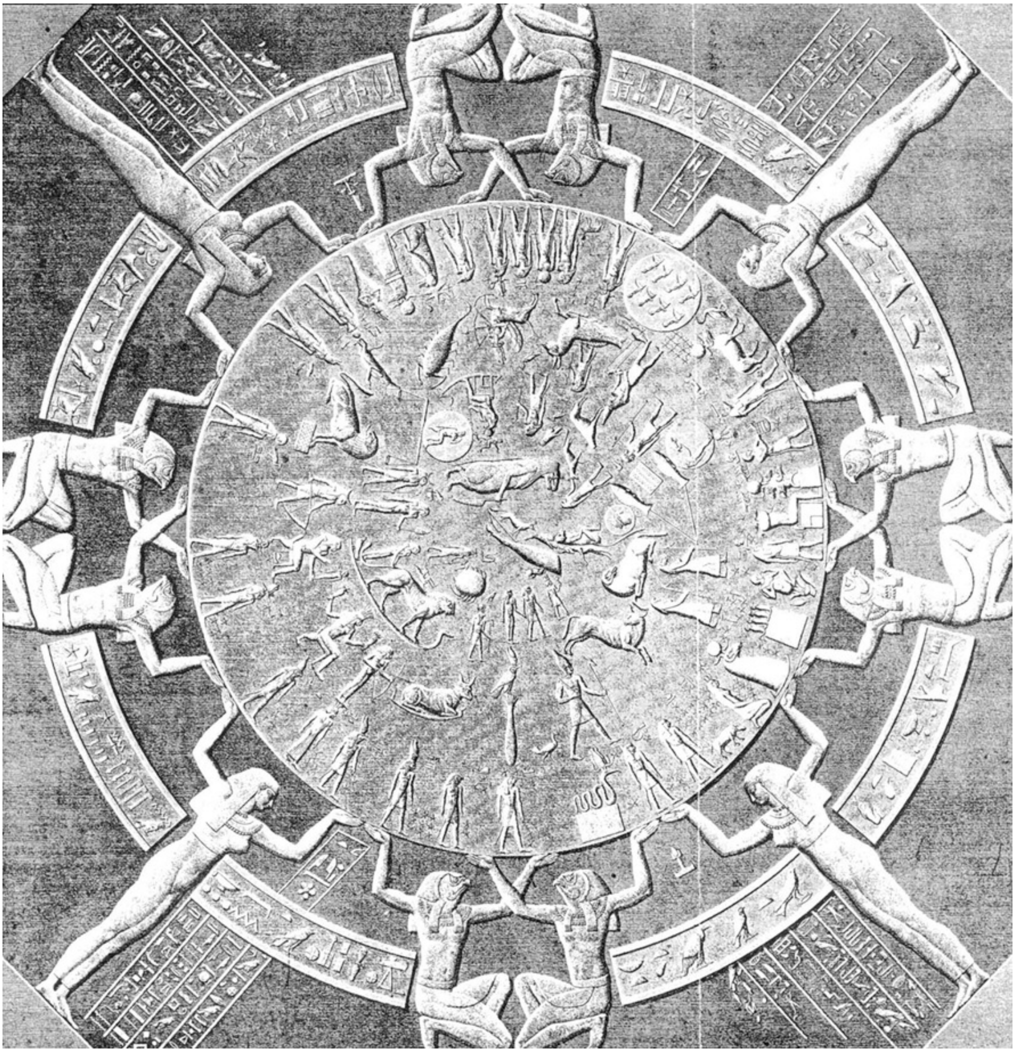

Fig. 12.10. A fragment of the Napoleonic shaded drawing of the Round Zodiac (DR). One sees some minor discrepancies in details as compared to the previous drawing. Taken from [1100], A. Vol. IV, Pl. 21.

conquest of Egypt, in 1766, the Mamelukes had once again managed to concentrate full power over Egypt in their hands. They had retained it for 30 years, up until Napoleon's expedition ([85], Volume 15, page 454). It is therefore possible that some of these "ancient" Egyptian temples really date to the second half of the XVIII century and were deliberately built in the "ancient Egyptian" (Mameluke) style, yet with all the technical achievements of the XVIII century employed. The Mamelukes may have tried to revive some of their old traditions in the XVIII century. In particular, they may have resumed the construction of temples with zodiacs indicating the years of holy or famous ancient events. Bear in mind that the Mamelukes hadn't been eradicated until 1811 ([85], Volume 15, page 455). Many "ancient" Egyptian traditions must have been wiped out as a consequence, and later dated to deep antiquity by the historians.

Another example is as follows. In fig. 12.17 we cite a drawn copy of the Egyptian zodiac discovered by the

Fig. 12.11. The Long Zodiac of Dendera (DL). The two halves of the zodiac located at a distance from each other, separated by the ceiling of the hypostyle hall, are drawn next to each other in the present shaded copy made by the Napoleonic artists. Taken from [1100], A. Vol. IV, Pl. 20.

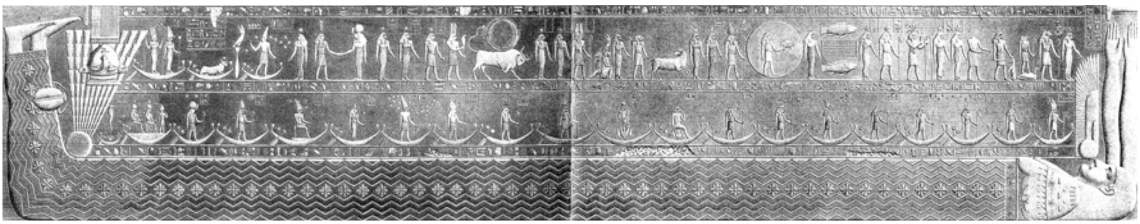

Fig. 12.12. The Long Zodiac of Dendera (DL). The previous illustration continued. The two halves of the zodiac are drawn as a single composition. Taken from [1100], A. Vol. IV, Pl. 20.

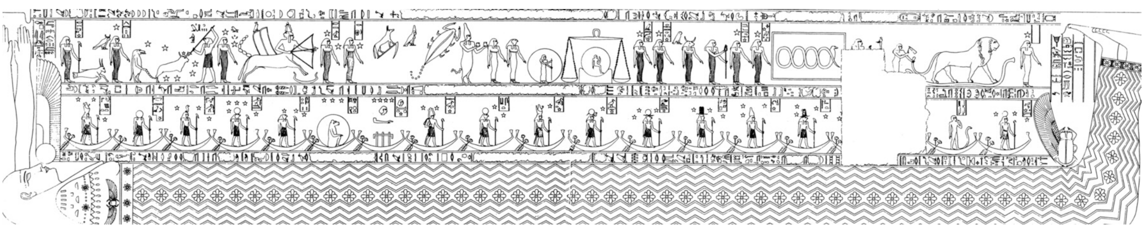

Fig. 12.13. The Long Zodiac of Dendera according to the drawing from the Napoleonic album on Egypt. General view. Taken from [1100], A. Vol. IV, Pl. 20.

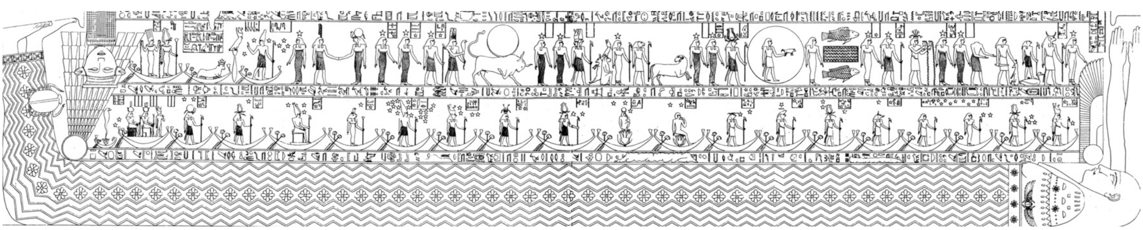

Fig. 12.14. The Long Zodiac of Dendera according to the drawing from the Napoleonic album on Egypt. General view (continued). Taken from [1100], A. Vol. IV, Pl. 20.

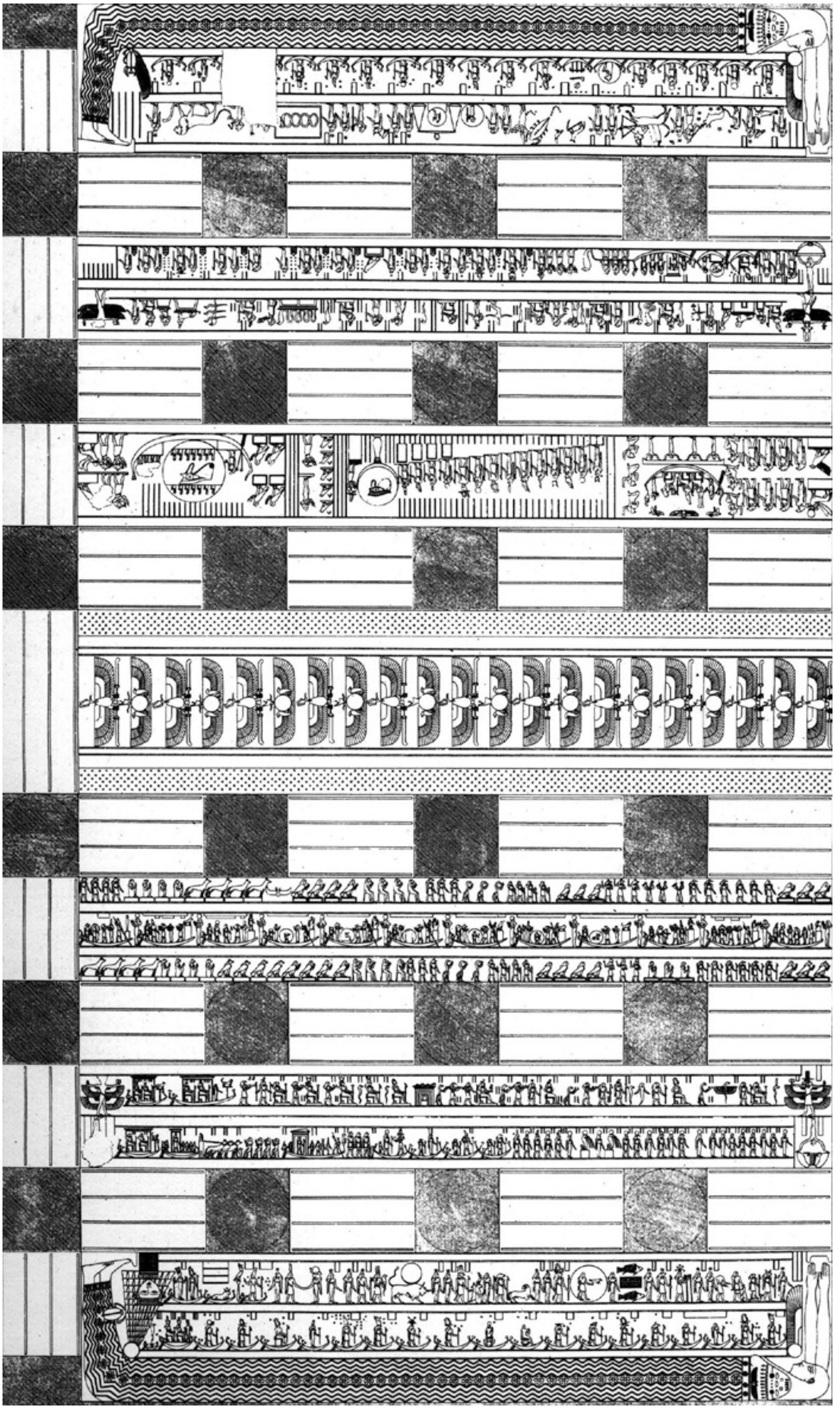

Fig. 12.15. General view of the ceiling of the hypostyle hall from the temple of Dendera (22 by 24.5 metres) – see [370], page 162. The two rectangular strips at the top and the bottom of the drawing comprise the Long Zodiac of Dendera. Shaded copy from the Napoleonic album ([1100]). Taken from [1100], A. Vol. IV, Pl. 18.

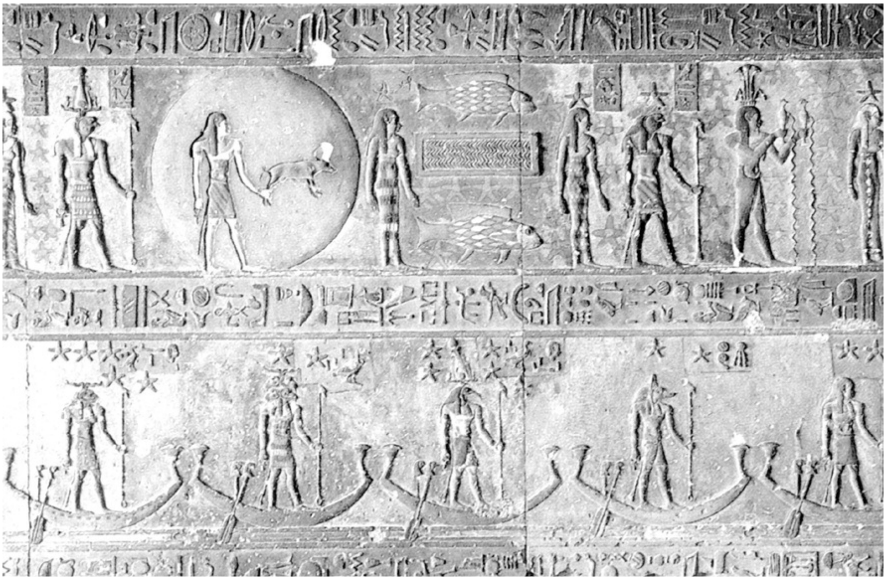

Fig. 12.16. Modern photograph with a small fragment of the Long Zodiac of Dendera. Taken from [1062], page 37.

famous Egyptologist Heinrich Brugsch on the inside of the lid of an "ancient" Egyptian wooden sarcophagus ([544], Volume 6, page 695). Here the symbol of the sky (the goddess Nuit) looks like a woman with her hands lifted above her head. She is dressed in a tunic and located in the centre of the picture, with the Zodiac to the left and to the right. The symbols used for zodiacal constellations are once again easily recognizable. They are situated along Nuit's body. On the left of fig. 12.17 we see the symbols for Cancer, Leo, Virgo, Libra, Scorpio and Sagittarius, whereas the symbols for Capricorn (with shaded head), Aquarius, Pisces, Aries, Taurus (shaded) and Gemini are on the right. The order of Zodiacal constellations is specified correctly, being the very same order they have on the celestial sphere. Furthermore, Heinrich Brugsch discovered demotic subscripts with the names of planets in this zodiac; these names are written explicitly between the figures of Zodiacal constellations. Brugsch managed to read them (see [376]; also [544], Volume 6, page 697) and estimate the places of planets in constellations. In other words, the zodiac of Brugsch contains the legible "subscript horoscope", which makes it feasible to date the zodiac in question astronomically.

The dating of the "subscript horoscope" from Brugsch's zodiac was first calculated by N. A. Morozov, yielding an astonishing result – 1682 A.D., the XVII century! The second possible solution (that of 18 October 1861) had been rejected by Morozov due to its being "too recent", since in 1862 Brugsch had already published a drawing of this zodiac in [1054]. However, we have discovered that apart from the "subscript horoscope", there are two more actual horoscopes on Brugsch's zodiac that represent an integral part of the latter. Therefore, today we can complement and clear up the conclusions made by N. A. Morozov in re the dating of Brugsch's zodiac. Below we tell the reader about this most noteworthy zodiac and its dating in full detail. We shall jump ahead and report that the dates ciphered in this zodiac (without accounting for the more recent subscript horoscope) are 6-7 October 1841 and 15 February 1853.

Therefore, the solution of 1861 is the one that becomes the most plausible one for the "subscript horoscope" – the year preceded the publication of Brugsch immediately. One of the Egyptians must have played a practical joke on Brugsch and drawn a horoscope for 1861 in demotic style, à la "Ancient Egypt" on the zodiac before demonstrating it to the "famous ideologist" in full realization that the latter wouldn't even conceive of looking for the astronomical dating of the "ancient" zodiac in the present year – or even the

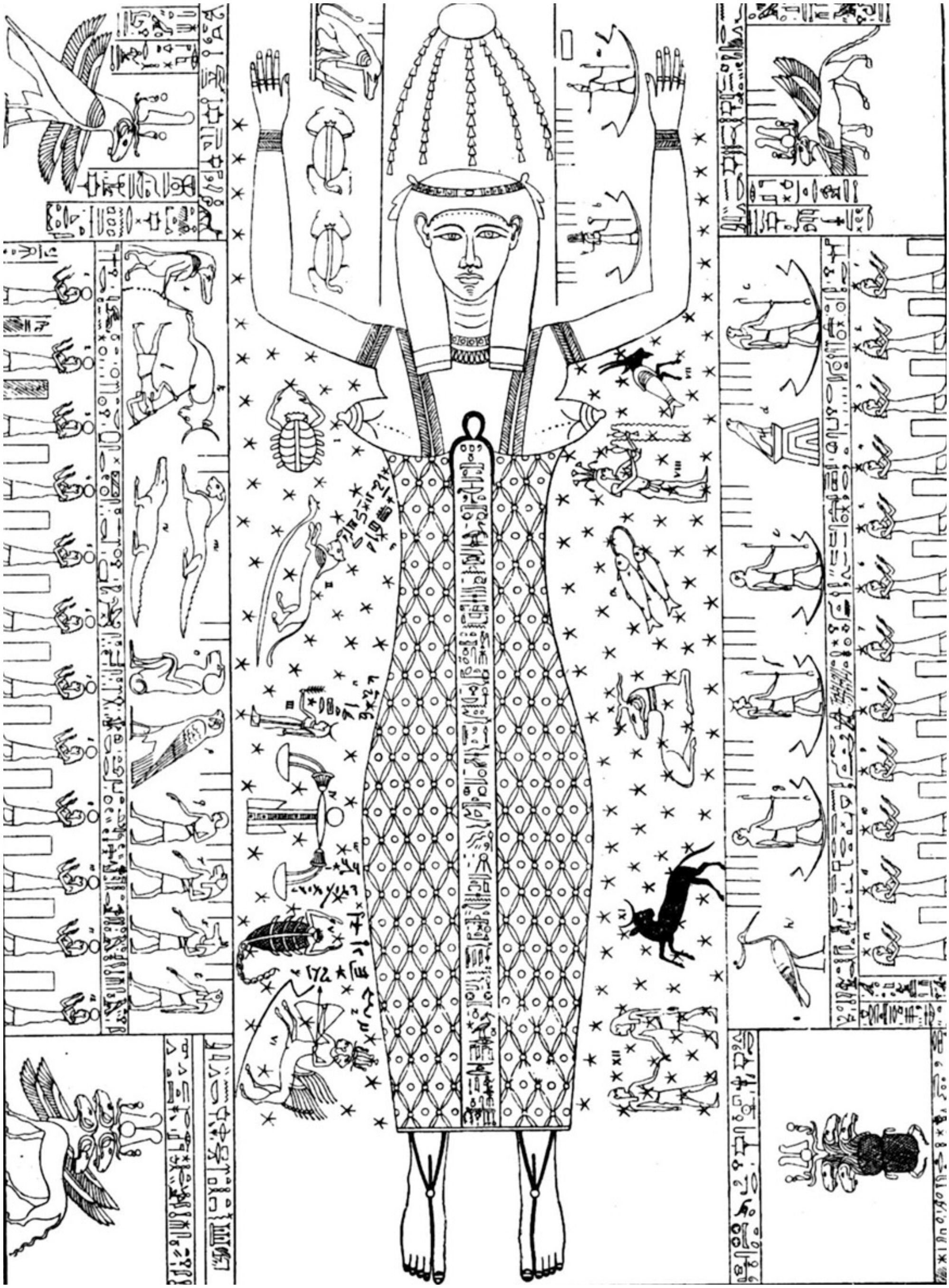

Fig. 12.17. A drawn copy of the BR zodiac from the inside of a wooden lid from an "ancient" Egyptian coffin. This drawing was published by Heinrich Brugsch in 1862 ([544], Volume 6, page 696). We can see the figure of Nuit with her hands raised into the air with symbols of zodiacal constellations to her sides. Brugsch had found a "subscript horoscope" here; the names of the planets are given in the subscripts on the left of the horoscope that were deciphered by Brugsch. Apart from that, there are two "native" horoscopes in the zodiac. They can be seen in the strips on the left and on the right. Taken from [544], Volume 6, page 696.

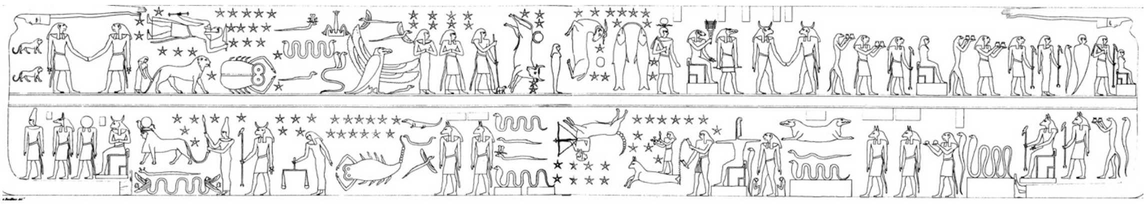

Fig. 12.18. Drawn copy of the EB zodiac from an ancient temple in the Egyptian city of Esna (also known as Isna and Latopolis). Ceiling relief carved in stone. We have cut the drawn copy in two for the sake of convenience. Taken from [1100], A. Vol. I, Pl. 79.

future, several years later. See fig. 12.17 where the subscripts near the constellation figures to the left of Nuit's body can be seen with sufficient clarity.

In fig. 12.18 one sees a drawn copy of a zodiac from one of the ancient towns in the Egyptian town of Esna (Isna). The old name of this town is Latopolis ([1100]). The present zodiac was also included into the Napoleonic Egyptian album, which is where we copied it from ([1100]). Let us refer to it as to the "Greater Zodiac" of Esna in order to distinguish it from the other zodiac, which was also found in Esna, but in a smaller table. A fragment of a shaded drawn copy of this zodiac from the Napoleonic album ([1100]) can be seen in fig. 12.19. See more about this zodiac and its dating below, in Chron3, Chapter 18. As we shall see, the date ciphered on this zodiac pertains to the end of the XIV century A.D., no less.

Another zodiac discovered in the small temple in the north of Esna is shown in fig. 12.20. It was also borrowed from the Napoleonic album in question ([1220]). We shall be referring to it as to the "Lesser Zodiac" of Esna (see more about this zodiac and its dating below). It turns out that the date ciphered herein is a XV-century one – namely, 1404 A.D.

Let us now tell the reader about the two zodiacs found in an artificial Egyptian burial cave at some point in the beginning of the XX century. Below, in fig. 13.9, one sees a drawn copy of these zodiacs. The cave with the zodiacs was discovered by the English archaeologist Flinders Petrie during his excavations in Athribis (a site in Upper Egypt, close to the town of Sohag – see [544], Volume 6, page 728). Two zodiacs were found on the ceiling of the cave, coloured in different hues ([544], Volume 6, page 729). Flinders Petrie provided a drawn copy of these zodiacs in [1340:1] presuming them to date from the beginning of the new era. See also Volume 14 of the British School of Archaeology in Egypt Courier with Flinders Petrie's article about the Athribis excavations of 1901.

The zodiacs of Athribis were studied by the English astronomer A. B. Knobel for the purposes of dating, and then also by M. A. Vilyev and N. A. Morozov ([544], Volume 6, pages 728-752). However, they had to go for far-fetching explanations in their attempts to decipher and date the zodiacs of Athribis. The reason for this shall be explained below. As a result, there wasn't a single astronomical solution found that would satisfy to the symbols found on the zodiacs of Athribis completely anywhere in the works mentioned above. Our research demonstrated that such a solution does in fact exist and it is the only one possible – it turns out that the Athribis zodiacs date to the XIII century A.D. (1230 for the Upper Zodiac and 1268 for the Lower Zodiac). Therefore, the date of their creation cannot predate the XIII century.

Let us point out that up until very recently no final dating of the Athribis zodiacs could be made since the volume of calculations required for this purpose happens to be too great to be performed manually, without the aid of modern computer technology. However, all of the researchers mentioned above were con-

Fig. 12.19. Fragment of the EB zodiac from Esna (Latopolis). Shaded drawing from the Napoleonic Egyptian album. Taken from [1100], A. Vol. I, Pl. 79.

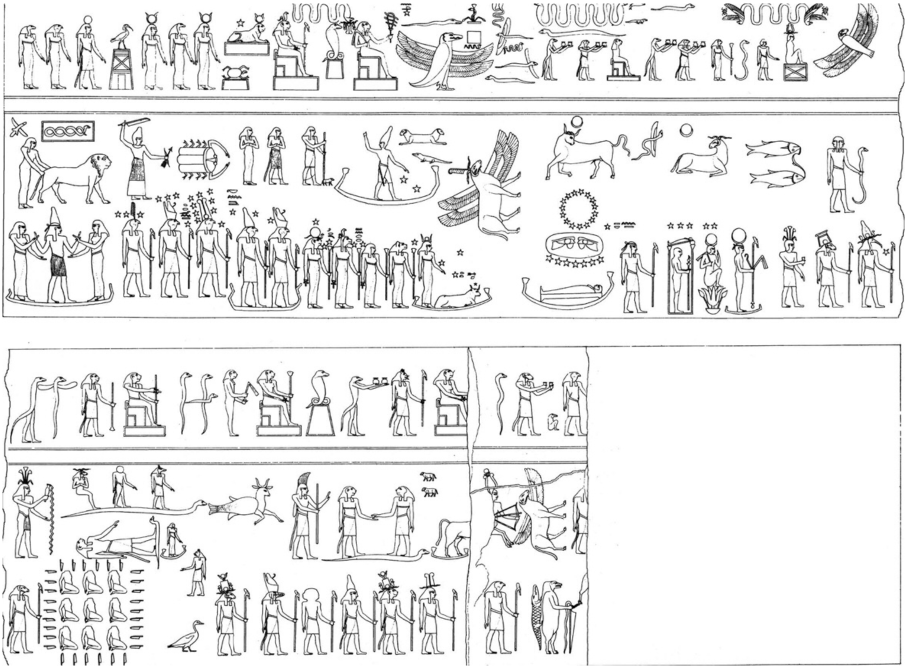

Fig. 12.20. Drawn copy of the EM zodiac from the Northern ("Lesser") temple of Esna. The copy is cut in two to fit into the layout. The part of the zodiac with the constellations of Virgo, Libra and Scorpio is lost. Taken from [1100], A. Vol. I, Pl. 87.

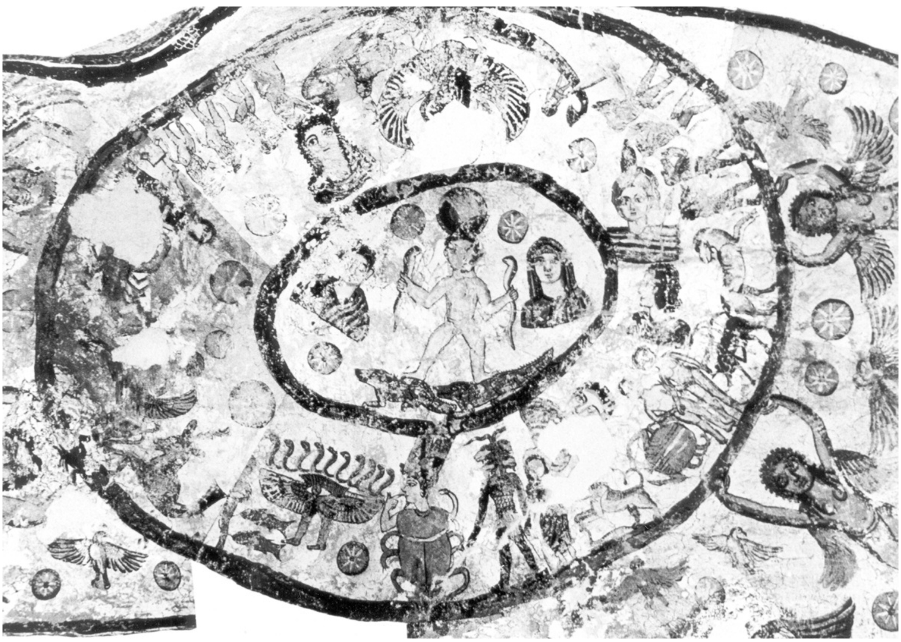

Fig. 12.21. Zodiac P2 found on the ceiling of the inner chamber of the ancient Egyptian sepulchre of Petosiris. The size of the entire piece of artwork is 2.12 by 2.62 metres ([1291], page 97). The constellation symbols are easily recognizable and located alongside the external circle. Planets are drawn as human portraits. Taken from [1291], Tafel 40.

fined to manual calculus and therefore had to introduce certain additional reasonable presumptions that would provide for curbing the volume of calculations to some extent. Unfortunately, these presumptions proved erroneous. Therefore, N. A. Morozov, for instance, who hadn't been bound by the Scaligerian chronology, still didn't manage to find a correct answer for the Athribis zodiacs.

In fig. 12.12 we see an example of an Egyptian zodiac where the constellations are represented as usual symbols, and the planets as half-length portraits. This zodiac was discovered in the middle of the XX century in the "ancient" Egyptian "Sepulchre of Petosiris", on the ceiling of the inner chamber ([1291], page 97).

Horoscopes are not contained in all Egyptian zodiacs. Some of them only possess Zodiacal constellation symbols sans planets. Such zodiacs cannot be dated astronomically as a rule due to the lack of horoscopes with dates ciphered therein. Approximate dating of such zodiacs is only possible if one is to compare them to similar ones, which do nonetheless permit to date them. An example of a horoscope-less zodiac can be seen in fig. 12.22. There are no planets on this zodiac – just zodiacal constellations.

There are certain examples of ancient Egyptian zodiacs containing less than twelve zodiacal constellations whose symbols differ from the ones used nowadays to a great extent – nevertheless, one can trace the general similarity well enough – see fig. 12.23, for instance; one can see an ancient Egyptian schist slate called the Libyan palette. It is most likely to be a zodiac where the constellations are represented as seven walled cities with the corresponding constellation symbol drawn above each of these cities (Leo, Scorpio etc) measuring its constellation with the use of a goniometric tool resembling a pair of dividers. Such instruments were in fact used in astronomy – the "ancient" astronomer Ptolemy would often be drawn with one of those, qv above in figs. 0.1 and 11.27. Even Copernicus had used a similar instrument by the name of "triquetrum" ([926], page 55). See fig. 11.26 above.

It is possible that such zodiacs are the oldest ones, manufactured in epochs when the division of the ecliptic into constellations hadn't assumed its modern form as to yet; it is possible that there were less zodiacal constellations at the time than nowadays.

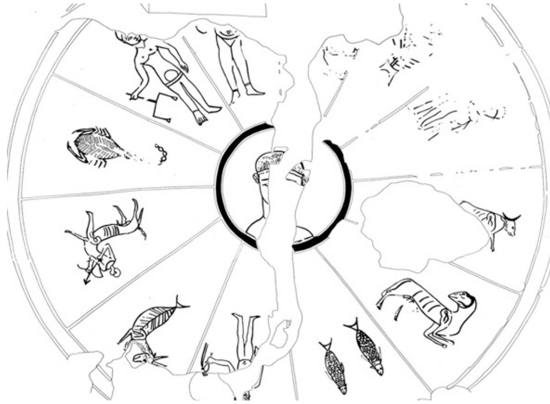

Fig. 12.22. Drawn copy of the zodiac found on the ceiling of the ancient Egyptian tomb of Petubastis. The entire piece of artwork is about 2.88 metres in diameter ([1291], page 100). There are no planetary symbols in the zodiac of Petubastis; thus, it contains no horoscope that could be used for its dating. Taken from [1291], Tafel 37.

Fig. 12.23. Ancient Egyptian stone tablet made of schist – the so-called "Libyan palette". It must be an older version of a zodiac with less constellations than twelve (which is the modern number). For instance, Scorpio and Libra are united into a single constellation. A propos, the old name of Libra was "Scorpio's Pincers" ([704], page 245). Leo and Virgo are also united into a single constellation. Instead of Cancer (or the Gemini/Cancer pair) we see Corvus. Taken from [1081:1], Chapter 17.

One finds echoes of this in the Almagest, for instance, where the constellation of Libra is called "The Claws of Scorpio" in the star catalogue; even though it is considered an independent constellation, the very name indicates that it may have once been part of the Scorpio constellation.

It is curious that one sees the constellation of Corvus in fig. 12.23. It is located next to Leo, which is where one would see either Cancer or Virgo nowadays. The actual constellation exists until the present day; however, it does not belong to the zodiacal belt, albeit a neighbour of the Virgo constellation. Nevertheless, in this Egyptian zodiac it is explicitly marked as a zodiacal constellation. We therefore see that in certain ancient Egyptian zodiacs the zodiacal constellations would be indicated different from the modern custom. However, in most of the Egyptian zodiacs the figures of zodiacal constellations are rather standard and hardly differ from their modern counterparts at all.

In fig. 12.24 we see a fragment of an old zodiac from the Slavic ***Izbornik Svyatoslava*** (Svyatoslav's Almanac) allegedly dating to 1073. The constellation of Pisces is represented by a single fish here and not by a pair, the way it is customary today.

2. THE ASTRONOMICAL DATING OF EGYPTIAN ZODIACS AND RELATED DIFFICULTIES. The reasons why the Egyptologists eschew the astronomical dating of the zodiacs

To evade miscomprehension, let us point out right away that every reference to the "Scaligerian chronology" in the present work doesn't attribute the datings to Scaliger himself, but his followers as well, or everyone who used the works of Scaliger as basis for the creation of the consensual version of history that proved erroneous, qv in CHRON1.

We already mentioned that if an old zodiac contains indications of planetary positions, or a horoscope, it must contain some ciphered date. Nowadays these dates can be deciphered with the aid of computational astronomy – or, at least, suggest several versions of its dating, which is what the very concept of dating the Egyptian zodiacs astronomically is based upon.

This idea is far from new. In the end of the XVIII – beginning of the XIX century, when the Europeans had secured access to Egypt for the first time, they discovered a large amount of zodiacs there. Some of the Egyptian zodiacs (the most impressive ones) were copied by Napoleon's artists and published in the Napoleonic album on Egypt ([1100]). They are directly referred to as "astronomical tables" or "sculptural zodiacs" there – see [1100], A. Vol. I, Pl. 79, or A. Vol. II, Pl. 82, for instance. Thus, the astronomical nature of the Egyptian zodiacs has never been doubted. Quite understandably, one would come up with the idea of dating these zodiacs astronomically, or employing horoscopes for this purpose. European astronomers of the XIX century have performed some calculations for this purpose.

However, since the astronomers had to conform to the orders of the historians, they also operated within the Scaligerian framework of Egyptian chronology. However, this is where astronomy contradicted Scaligerian chronology blatantly. No dating that would satisfy the Scaligerites has ever been found.

Let us linger on this for a while, starting with the mention that nearly all the Egyptian zodiacs date to the epoch of Roman rule in Egypt, according to historians, or the beginning of the new era ([1017:1], page 38).

In the earliest stages, attempts were made to date these zodiacs to even more distant epochs. Historians would try to date the Dendera zodiacs to an epoch preceding the new era by 15.000 years, no less ([544], Volume 6, page 651).

However, these exceptionally "attractive" datings of Egyptian zodiacs must have been complicated by the all too obvious similarity between the astronomical symbols used in Egypt and in Europe, and so in order to insist that Egyptian zodiacs predate the new era by hundreds and thousands of years one would have to explain the reason why the drawings of constellations on these exceptionally ancient Egyptian zodiacs coincide with the pictures in mediaeval European books on astronomy in finest detail. Dating the Egyptian zodiacs to the beginning of the new era would make the problem a great deal less serious, since this dating allows to make claims that both the "ancient" Egyptians and the mediaeval Europeans borrowed their astronomical symbols from the Romans, hence the similarity.

Fig. 12.24. A drawing of six constellation from ***Izbornik Svyatoslava*** (Svyatoslav's Almanac), a Slavic manuscript allegedly dating from 1073. It is noteworthy that the constellation of Pisces is drawn as a single fish and not a pair of fishes. Taken from [745], Volume 9, page 108.

Shifting the dates forward from the first centuries of the new era would also prove a non-option for the Scaligerite experts in Egyptian history since the Scaligerian chronology is of the opinion that the history of the "ancient" Egypt ceases shortly after the beginning of the new era. The zodiacs that one discovers in the "doubtlessly ancient" Egyptian temples and sepulchres cannot be dated to an epoch post-dating the first A.D. centuries within the framework of Scaligerian chronology.

As a result, possible (according to the Scaligerites) datings of ancient Egyptian zodiacs turn out hemmed in the narrow interval of 200-300 years the longest – a century before the beginning of the new era, or possibly a century or two after. Too great a distance between the hypothetical dating and the boundaries of this interval begins to contradict the entire Scaligerian concept of "ancient" Egyptian history and chronology rather explicitly.

However, it turns out that this period has got absolutely nothing to do with the astronomical datings of the Egyptian zodiacs, since a calculating astronomer has no leeway at all in order to try and make the datings fit, since one and the same horoscope can only recur after prolonged intervals of time and happen once or twice a millennium. Some planetary combinations can only recur over the course of several thousand years; therefore, making a given zodiac fit the short time interval specified by historians proved too hard, no matter how lenient the criteria for "fitting". All these complications arose from the fact that the interval was specified wrongly.

The result was that the Egyptologists basically gave upon the idea of dating the Egyptian zodiacs by their

astronomical content. Discussing the symbolic content of the Egyptian zodiacs, they try to present it as "astronomical fantasies" of ancient artists, often not even trying to decipher and date the rediscovered Egyptian zodiac.

A vivid example is [1291], a work by famous specialists in the field of studying the astronomical texts of ancient Egypt – O. Neugebauer, R. A. Parker and D. Pingree. In their analysis of the zodiacs from the ceilings of two ancient Egyptian sepulchres belonging to Petosiris and Petubastis, the authors of [1291] write the following, for instance: "The positioning of the planets seems to be inspired by Mithraism" ([1291], p. 100). In other words, they reject the idea that the zodiacs contain real horoscopes, which may be dated – there isn't a single mention of such a possibility anywhere in [1291]. Nevertheless, the two zodiacs of Petosiris considered in said work contain horoscopes, which can be dated astronomically. It is just one of the three zodiacs that contains no horoscope and therefore no ciphered date – that of Petubastis, qv in fig. 12.22.

Let us emphasize that it isn't any random planetary dislocation against the background of zodiacal constellations that can be treated as a horoscope, which can really manifest on the celestial sphere. Planetary motion is subject to certain laws. For example, Venus and Mercury as seen from the Earth cannot be located too far away from the Sun, and hence from each other as well.

A fantasy artist distributing planets across constellations randomly is most likely to break these laws and draw an unreal fantasy horoscope. However, Egyptian zodiacs, and, particularly, the zodiacs of Petosiris considered in [1291], contain real horoscopes. Why would the authors of [1291] have to present us with vague ruminations on Mithraism affecting the planetary symbols on the Zodiacs instead of analyzing their astronomical content? Could it be due to the fact that they didn't even hope to come up with a solution that would correspond to the Scaligerian chronology? Indeed, neither the zodiac of Petosiris nor any other Egyptian zodiacs have such solutions.

Let us take a look at what is written on the subject of dating Egyptian zodiacs astronomically in the description of the British Museum's Egyptian collection published in 1924, for instance ([1050:1]). We find nothing at all. The authors report nothing about the astronomical datings of the zodiacs found on these coffins when they tell us about the alleged dates when the "ancient" Egyptian sarcophagi from the collection of the British Museum were manufactured, as if these horoscopes didn't matter at all. Each and every dating we find in [1050:1] is given out of considerations that have got absolutely nothing to do with astronomical dating.

For example, when the authors of [1050:1] describe an allegedly "mind-bogglingly ancient" wooden coffin from Egypt, they tell us that "the face resembles the face of the ordinary stone Sidonian sarcophagus, of which those of Tabnith and Eshmunazar, King of Sidon, B.C. 360 … are typical examples, and for this reason the date of the coffin is supposed to lie between B.C. 500 and B.C. 350" ([1050:1], page 133).

However, right here in [1050:1] we find the following description of the artwork that decorates the coffin lid – it depicts "numerous astronomical texts and pictures … Here we have figures of the gods of the constellations, and of the planets, Signs of the Zodiac …" ([1050:1], page 133). In other words, what we have before us is a zodiac with a horoscope, yet the issue of dating this horoscope astronomically is ignored altogether. This is very typical. Not a single Egyptian zodiac out of those mentioned in [1050:1] was dated astronomically or so much as represented. There isn't a single word about such datings anywhere in the very detailed description of the British Museum's Egyptian collection ([1050:1] – [1050:3]), despite the fact that the actual presence of the zodiacs is accurately pointed out.

A vivid example of the abovementioned situation with the datings of Egyptian zodiacs is given by the history of the astronomical dating of the two zodiacs from the Dendera temple. We already mentioned one of them above – the Round Zodiac. This is what N. A. Morozov wrote in re the zodiacs from Dendera:

"The first Egyptologists dated the Temple of Dendera to fifteen thousand years before Christ, no less; their children dated it to three thousand years before the new era, and their grandchildren had to admit that the Rectangular Zodiac dates to the reign of Tiberius (14-36 A.D.), and the Round Zodiac – to the reign of Nero (before 60 A.D.). When they tried to prove all these datings by astronomical calculations, the results obtained were negative.

The consecutive works of Dupuis, Laplace, Fourier, Letron, Holm, Bio and other later researchers demonstrated that the horoscopes in question cannot predate the III century A.D. One had to either date the imperial Roman reigns to a different epoch, also ascribing a different geographical location to it, or, alternatively, to declare the horoscopes pure fantasy. The Egyptologists were reluctant to revise the tradition and opted for the latter despite the fact that the veracity of both horoscopes is blatantly obvious" ([544], Volume 6, page 651).

After an attentive study of these zodiacs, N. A. Morozov makes the following conclusion:

"Should all of the above to be artistic fantasy, it is very difficult to explain why both Mercury and Venus occupy their rightful position near the Sun in both zodiacs rather than winding up somewhere else, in a location convenient for the artists, but perfectly impossible? Why would one draw such a fantasy horoscope in the first place? Nonsense! This horoscope isn't "fantasy" in any way – it is perfectly real …" ([544], Volume 6, page 653).

We shall come back to N. A. Morozov's analysis of the Dendera zodiacs in Chapter 17 of CHRON3 and tell the reader about it in more detail.

Morozov had been the first to suggest dating the Egyptian zodiacs by their astronomical content regardless of the Scaligerian chronology. All the researchers who preceded Morozov tried their hardest to come up with a solution that would lie in the a priori specified late B.C. – early A.D. interval, which would either prove impossible or next to impossible, requiring all sorts of approximations and arbitrary measures to become more or less fitting.

Whether or not it is a coincidence, but all the earnest attempts of the Egyptologists to use astronomy for the dating of Egyptian zodiacs ceased de facto after the publication of N. A. Morozov's works where he proves the impossibility of dating the Egyptian zodiacs the way Egyptologists want them to be dated – all the resultant datings are mediaeval ([544], Volume 6). This contradicts the consensual chronology of Egypt.

It has to be said that N. A. Morozov's works on the astronomical dating of the zodiacs contained a number of minor flaws, which will be analyzed in detail below. However, there were a lot less of those in Morozov's work than in any of the ones that preceded it, since the authors of the latter would do everything they could in order to make the resultant datings correspond to the Scaligerian chronology of Egypt. The works of Morozov prove that once we become a little more demanding precision-wise, the astronomical datings irreversibly shift forwards, into the Middle Ages.

We therefore have to repeat our question – is it a chance occurrence that the activity of the Egyptologists in the field of dating the Egyptian zodiacs astronomically receded greatly after the publication of Morozov's works? Nowadays they do their best to evade astronomy while discussing Egyptian zodiacs and to change the subject of the conversation as soon as possible. The solution of an actual problem formulated as deciphering the astronomical content of the zodiacs and their meticulous dating is substituted by an obfuscating discussion of ancient Egyptian religion, which is the safest option for Scaligerian chronology. The matter is presented in such a light that even if the Egyptian zodiac symbols rear any relation to astronomy at all, they are extremely naïve and fantastical ([1291] and [320]).

However, our research (which follows in the footsteps of N. A. Morozov's research, for instance) demonstrates that the Scaligerian chronology rests upon a foundation of thin air, and is most likely to be highly erroneous, qv in CHRON1 and CHRON2. Therefore, N. A. Morozov's approach to the dating of Egyptian zodiacs without accounting for the Scaligerian chronology appears to be a perfectly correct one. However, this approach runs into a new hindrance, and a significant one. It becomes manifest as soon as we expand the time interval of acceptable datings to make it span a millennium or more – the historical epoch that comprises the "antiquity" and the Middle Ages, in other words. The resulting dates are very ambiguous. The reason is as follows.

Once we reject the a priori set narrow time interval for the horoscope datings, we must take into account every astronomical solution on the entire historical interval length, or roughly two thousand years, which is a long enough time interval allowing for multiple recurrence of many zodiacs. This spawns several valid solutions for every zodiac, complicating the dating as a result, since it is perfectly unclear how

a single correct dating could be identified amidst a number of variants.

It has to be said that if we had to consider a shorter timeframe of 2-3 centuries, the probability of several possible solutions for a single zodiac manifesting within an interval this brief would be very low. Therefore, a correctly specified short interval would be most likely to yield a single possible solution for each zodiac. However, should the interval turn out to be specified incorrectly, there won't be any fitting solutions in most cases, and this is precisely what we see to be the case with the Scaligerian time interval for Egyptian horoscopes for which we find no satisfactory solutions.

However, even if we're fortunate and the horoscope of our zodiac proved successful enough to possess a single possible solution on the entire historical interval, the problem retains. The matter is that all attempts to decipher Egyptian zodiacs are still afflicted by ambiguity, even in cases when the symbols can be deciphered unequivocally and reliably.

One must point out that a great number of Egyptian zodiacs can be deciphered with no ambiguity whatsoever. The names of the planets are given in writing on some of them; these inscriptions can be read in order to realize what planet exactly this or the other zodiacal symbol stands for. Some of the planetary figures recur on different zodiacs and can therefore be told apart securely when compared to each other. Below we shall describe this procedure in more detail. Nevertheless, deciphering the Egyptian zodiacs always results in ambiguities of some sort concerning a planet or two, for instance. There are many reasons for this – sometimes it happens due to the fact that the symbol for a given planet isn't known to us from other zodiacs, or because the planetary symbol in question is new and wasn't encountered earlier; the condition of the symbol may also be poor enough to render it completely unidentifiable. It is also possible that a zodiac might not specify a planet's position explicitly enough to identify this planet – there are certain other reasons as well. For certain zodiacs that utilize complex, convoluted or extremely abstract symbols one has to go through all possible identification versions of the planetary figures, which results in dozens of possible ways to decipher such a zodiac, with several hundred possible solutions. In other cases there are just two or three variants.

However, whether or not there are multiple ways to decipher a given zodiac, none of them are free from ambiguity. Even if the general picture is clear, certain variations are still possible, which leads to several solution possibilities.

3.
OUR NEW APPROACH TO THE DATING OF EGYPTIAN ZODIACS

The abovementioned problems are instantly solved by the new method of deciphering and dating the Egyptian zodiacs as proposed by the authors. Namely, we suggest the formal approach that permits a decipherment of the zodiac itself as well as the additional information, which is usually inherent therein. This extra information usually suffices for us to reject all the unnecessary solutions and define the date for a given zodiac quite unambiguously.

Let us emphasize that the solution turns out unambiguous even if we are to consider a certain vagueness of the primary horoscope, as well as the secondary information that it contains. Furthermore, even if the primary horoscope was deciphered with errors for some reason, the secondary information it contains is most likely to render the incorrectly deciphered version void of solution since when we have too many astronomical conditions to account for, their chance combination upon the real celestial sphere becomes highly improbable, even considering the multitude of possible interpretations that arise when we attempt to decipher the Egyptian zodiac.

A detailed description of our method is given in the subsequent sections. Bear in mind that the method in question allows us to work with all possible options of deciphering the Egyptian zodiacs, which the previous approach did not permit. The volume of necessary calculations will naturally grow, since one has to perform them for several horoscope variants for each zodiac. Each one of those can generate a whole series of acceptable solutions on the historical interval. The total number of solutions for a single zodiac can approach and even exceed a hundred. Each one of them needs to be tested for correspondence with the zodiac's secondary astronomical data.

This procedure is impossible without modern computers and state-of-the-art astronomical soft-

ware. Furthermore, we had to develop a separate computer program for this purpose. It is called HOROS and serves the purpose of searching all the dates from the historical interval for real manifestations of given planet dispositions in zodiacal constellations (horoscopes). The zodiacal belt dispositions of planet in relation to each other are also considered. Since there can be several ways of reading data from a zodiac, this software accounts for possible ambiguity in the distribution of planets across the constellations as well as the mutual planetary order. See Annexes 2, 3 and 4 for a description of the HOROS software, and also CHRON3, Chapter 16.

For approximated calculations we used the simple and convenient application called Turbo-Sky and developed by A. Volynkin, a Muscovite astronomer. It was employed to estimate the visibility conditions for the calculated dates from the Egyptian zodiacs – in particular, the luminosity of planets for a given time moment, which is very important in order to assess whether or not the planet in question can be observed with the naked eye. Let us mention that the luminosity of a planet as seen from the Earth is largely dependent on the distance between said planet and the Sun, which can oscillate wildly over the course of time. See CHRON3, Chapter 16, for more information.

4. THE FUNEREAL CHARACTER OF ZODIACS IN EGYPT

"Most of the surviving artefacts [from Ancient Egypt – Auth.], as well as the inscriptions found upon them … are of a religious character. Out of the papyri that had reached our day, about 9/10 happen to have religious content … all this material lacks diversity, since it deals with the funereal rites that had existed at the time" ([965], page 101).

Let us enquire why the ancient Egyptians would draw zodiacs with ciphered dates? Although this issue doesn't bear any direct relation to the problem of dating the Egyptian zodiacs astronomically that we're considering presently, it is related to it implicitly.

Indeed, let us suppose that we managed to discover the astronomical dating of some old Egyptian zodiac. What could this dating possibly stand for? If a certain zodiac was discovered upon the ceiling of an "ancient" Egyptian temple, could the date ciphered therein stand for the approximate date of this temple's construction? A propos, this is exactly how N. A. Morozov suggested to interpret the astronomical datings of the Dendera zodiacs. He was of the opinion that they contained "the date when the construction of these parts of the building began, or, perhaps, the time they were made open for the public" ([544], Volume 6, page 653). However, our opinion differs from Morozov's.

Let us pay attention to the following circumstance. The "ancient" Egyptian zodiacs are almost always explicitly linked to burials. Let us peruse the description of the British Museum's Egyptian collection, for instance ([1050:1], [1050:2] and [1050:3]). Nearly all of the Egyptian zodiacs mentioned in these descriptions are drawn upon the inside of the "ancient" Egyptian coffin lids. The zodiacs cover the mummy, in a way; they are drawn so as to be as close to the mummy as possible. Therefore, the dating ciphered in such a zodiac is most likely to bear direct relation to the deceased, being the year of his birth, or death, for instance – or both, if there are several horoscopes in a zodiac (which is the case sometimes).

There are several "ancient" Egyptian sarcophagi made of wood in the collection of the British Museum with zodiacs drawn upon them. Four of them are mentioned in the description of the third room containing the Egyptian collection ([1050:1], pages 126 and 133). We see one such sarcophagus in fig. 12.25. It is covered with a curved wooden lid with decorations; a similar coffin sans lid can be seen in fig. 12.26. A closer look tells us that these "ancient" Egyptian coffins were made of smooth and well-planed planks of wood. Furthermore, the planks are mortised together – the woodwork method in question might as well be modern (see fig. 12.27). Such coffins are unlikely to have been manufactured in absence of iron axes, planes and chisels – yet we are told that the "ancient" Egyptian makers of these coffins had nothing but copper tools at their disposal.

The decorations can be found both on the inside and the outside of Egyptian coffins, qv in fig. 12.27.

In their description of a typical "ancient" Egyptian coffin, the authors of the Egyptian collection's description ([1050:1]) inform us that the inside of a coffin's lid would usually be decorated with a draw-

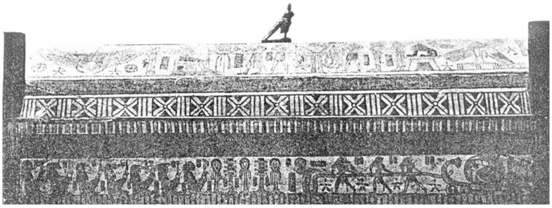

Fig. 12.25. A typical "ancient" Egyptian wooden coffin from the "Roman period". The cruciform ornament on the outside instantly draws our attention, since one often finds such ornaments in Christian symbolism. We learn from [1050:1] that on the inside of the lid one can find an Egyptian zodiac with the goddess Nuit and the symbols of the 12 constellations. Unfortunately, we find no photograph of the actual zodiac anywhere in [1050:1]. The general composition of such zodiacs is usually the same as in fig. 12.17. Taken from [1050:1], page 127, Plate XXI. Third Egyptian Room, Standard Case EE.

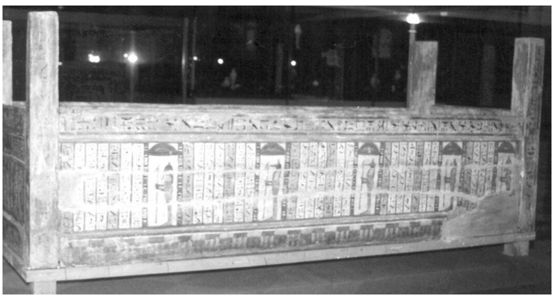

Fig. 12.26. An "ancient" Egyptian painted coffin, lidless. Exhibited in the Egyptian hall of the State Hermitage in St. Petersburg, Russia. Photograph taken in 2000.

ing of the goddess Nuit symbolizing the celestial sphere as well as the twelve signs of the "Greek Zodiac" ([1050:1], page 32). In other words, the sarcophagi were decorated with Egyptian zodiacs.

It is just one of the horoscopes mentioned in [1050:1]-[1050:3] that was drawn on a piece of glass and not a coffin – and one without a horoscope at that, since it only contains the twelve constellation symbols ([1050:2], page 88).

Thus, we see that nearly all of the Egyptian zodiacs kept in the Egyptian collection of the British museum are zodiacs drawn for burials upon the inside of lids covering the "ancient" Egyptian coffins.

Let us note that most of the Egyptian zodiacs that we were alluding to above are also related to funeral rites. Brugsch's horoscope is drawn on a coffin lid, and the horoscopes of Athribis – upon the ceiling of a cave used for burials. Zodiacs in figs. 12.1 and 12.3 come from the ceilings of the sepulchres in the Valley of Kings near Luxor. The zodiacs of Petosiris and Petubastis are also drawn upon ceilings of crypts.

One gets a distinct impression that the Egyptian zodiacs were part of the funeral rites. It would make sense to assume that they were used for recording the dates related to the deceased – the dates of his birth and death and, possibly, some other ones considered important.

But why would these dates have to be ciphered in a horoscope and not written normally? The "ancient" Egyptians who drew the horoscopes upon the ceilings of their sepulchres must have been well-versed in chronological issues already, realizing that the usual everyday method of date transcription (counted from the beginning of some reign, or according to some era) is far from eternal; some new reference point for the beginning of an era may eventually be introduced, and the old one forgotten. Or, alternatively, the letters and numbers used for transcribing a date might eventually alter to a great extent, which would render the usual dating incomprehensible for the descendants. Therefore, another method of transcribing the dates for the dead was required – an "eternal" method, as it were. The horoscope was chosen as such a method, or the distribution of planets across zodiacal constellations. Astronomy must have been evolved to a sufficient extent by that time for people to realise that the recurrence of a zodiac on a celestial sphere is a very rare occurrence indeed; another implication is that one could really use the method in question in order to transcribe a date. Such a transcription would be "eternal as the sky itself".

Thus, the astronomical dating of a zodiac drawn upon the lid of an Egyptian coffin, or upon the ceiling of an Egyptian burial cave (sepulchre) can really be considered as the approximate burial date. Naturally, one should not exclude the possibility that the date ciphered in the funereal zodiac had absolutely nothing to do with the birth or the death of the deceased and was related to some famous predecessor of his – the founder of his lineage, perhaps, with the zodiac calculated for his epoch in reverse. However, such cases must have been rather rare if they took place at all, and so the date of the horoscopes found

on most Egyptian sepulchres can be considered to relate to either the birth or the death of the deceased; it is thus the approximate dating of the burial.

On the other hand, if it isn't a sepulchre that the horoscope is drawn upon, but rather a temple, it would be unlikely to refer to this temple's construction date. Let us expound this idea.

The date of a temple's construction as well as the circumstances related thereto in general don't usually occupy a crucial place in the murals of said temple, let alone ceiling artwork. The events depicted in temples with the utmost care and attention are usually the ones that the temple had been built to commemorate; they must have been old enough by the time of the temple's construction, since temples are usually built to commemorate ancient events and decorated accordingly – even in cases when the temple is built to commemorate a more or less recent event.

The zodiacs discovered in the "ancient" Egyptian temples of Dendera and Esna are large reliefs carved in stone and placed on the ceiling of the temples' central chambers where they could be seen by everyone. If we are to make a comparison with the Russian temples, for instance, the Egyptian zodiacs will correspond to the artwork under the dome, which never tells the tale of the temple's construction.

Therefore, the most plausible assumption is that the datings on the zodiacs found in Egyptian temples relate to the life of the saint that the temple in question was built to commemorate and indicate the day of this saint's death, or other important events related to this character.

For instance, if the ancient Egyptian temple was dedicated to the Nativity of Christ, a zodiac with Christ's birth date could easily be painted on the ceiling of this temple. The builders of the temple didn't have to remember the disposition of the planets for the day of the Nativity; the planetary disposition for the required date (horoscope) is most likely to have been calculated in reverse, which is a rather easy task due to the fact that planetary positions are given very roughly; it suffices for a given planet to be withing the confines of a zodiacal constellation. Therefore the calculation of a horoscope didn't require anything more esoteric than the knowledge of Ptolemy's planetary theory. This task was perfectly feasible for the mediaeval and "ancient" astronomers.

Fig. 12.27. An "ancient" Egyptian wooden coffin from a closer distance. One sees that it's made of ideally smooth and polished planks of wood. We see grooved joints, which require planes and chisels. However, we are being convinced that the "ancient" Egyptian craftsmen had no steel instruments whatsoever – only copper ones. From a photograph made in the Egyptian hall of the State Hermitage in St. Petersburg, Russia (2000).

Therefore, the dating of a zodiac from an Egyptian temple as opposed to a zodiac from a sepulchre cannot serve for the dating of the actual temple. Nevertheless, it does serve to provide the bottom line of the latter. It is obvious that the temple could not have been built earlier than the date contained in its zodiac. However, it could have been built later than that date, and probably a great deal later as well – several centuries later, perhaps.

5. REPRESENTATIONS OF THE EGYPTIAN ZODIACS AS USED BY THE AUTHORS

The analysis of symbols used in Egyptian zodiacs as well as deciphering them shall require attention to the tiniest details. According to our research, small and seemingly insignificant details of a zodiac, as well as the mutual disposition of the symbols upon it, often turns out to be of paramount importance, capable of affecting how the zodiac in question is deciphered. Therefore it is vital for the purposes of astronomical dating that the representations of the zo-

diacs be as detailed and as clear as possible. The best option is high-resolution colour photographs.

Unfortunately, so much as procuring photograph turned out impossible in a number of cases. Finding quality photographs of certain Egyptian zodiacs, even famous ones, proved a very difficult endeavour.

Could this be a chance occurrence? Above we already mentioned the fact that modern Egyptologists are prone to treating Egyptian zodiacs as astronomical fantasy. At the same time, one finds modern publications with detailed and high-quality representations of the zodiacs to be next to nonexistent.

In other words, there are almost no publications in existence that would permit to date these zodiacs astronomically. Even if one manages to find published photographs of the zodiacs, they are either of very poor quality, or only contain fragments of zodiacs. Exceptions do exist, but they are few and far between.

Could we be facing a case of "extreme care" about the integrity of the Scaligerian chronology from the part of the Egyptologists, which could explain their reluctance to publish materials that represent a potential basis for non-Scaligerian datings? After all, in the XIX and the beginning of the XX century, when the Egyptologists had still cherished the hope of confirm the Scaligerian chronology of Egypt with the aid of astronomical dating, they got to publish a great many high-quality and detailed prints of Egyptian zodiacs – see [1100], [1340:1] and [1054]. We studied all of these prints, and they shall be reproduced below.

Very high-quality and detailed reproductions of several Egyptian zodiacs are contained in the Napoleonic description of Egypt ([1100]). It was published in France in the beginning of the XIX century in the wake of the Napoleonic expedition to Egypt that had taken place in 1798-1801. We were using a modern reprint ([1100]).

In our research we have used all the painted, drawn and photographic copies of the Egyptian zodiacs as listed below.

1) The Round Zodiac of Dendera, also known as "The Zodiac of Osiris" ([1062]). It is a ceiling relief carved in stone, qv in fig. 12.8.

The Napoleonic album contains a drawn copy of this zodiac, and also a shaded drawing (see [1100], A. Vol. IV; Pl. 21). All the symbols on the zodiac have been copied, including small details. The artists endeavoured to attain photographic precision, and they almost succeeded. Comparing a drawn copy of the Round Zodiac of Dendera to the photographs of the original made in the Louvre in the year 2000 demonstrate the drawn copy to be all but free of errors. The existing minute discrepancies only concern some details pertaining to mutual planetary disposition or certain finer points of writing hieroglyphs. There aren't many of these, although some of them proved to be important.

In general, our comparison demonstrates that one can trust the illustrations from the Napoleonic album – insofar as the rectangular zodiacs are concerned, that is, since in their case the details of mutual figure disposition are insignificant for the purposes of deciphering the zodiacs, seeing as how all the figures are presented in a row. As for the round zodiacs, there is only one such item in the Napoleonic despription; namely, the Round Zodiac of Dendera. Fortunately, we have modern photographs of this zodiac, and they answer all the questions that may arise in this respect.

The Round Zodiac of Dendera has survived in its entirety. There had been no losses, chips, chiselled-off figures etc when the drawn copy was made. According to modern photograph, the zodiac remains in excellent condition.

2) The Long or Rectangular Zodiac of Dendera is a ceiling relief carved in stone. It is a zodiac of the rectangular type, which means that all of its outlines are rectangular, and the figures are lined up in rows.

There is a shaded copy and a drawn copy of the Long Zodiac likewise the Round (see [1100], A. Vol. IV, Pl. 20). In [1100] one also sees a drawing of the entire ceiling where the Long Zodiac was found. The actual Long Zodiac is part of a large ceiling decoration ([1100], A. Vol. IV, Pl. 18).

We have already pointed out the fact that copying rectangular zodiacs is an endeavour that has less strict precision criteria than making copies of round zodiacs. The artist copying a round zodiacs is higly likely to make a mistake in the distribution of figures across the entire field, even if this artist has knowledge of astronomy due to incomplete understanding of the Egyptian figures' astronomical meaning and ignorance of finer details concerning their mutual dispo-

sition. A slight shift in the position of a figure as related to that of other figures surrounding it might result in the loss of an important detail of the astronomical description. Below we shall cite some such examples. In the rectangular zodiacs, a slight shift of a figure's position in relation to other figures does not affect the astronomical meaning of the picture. Furthermore, each of the figures only has two neighbours, and so the mutual disposition of figures is easier to copy.

Thus, the quality of the Long Zodiac's copies in the Napoleonic album ([1100])is high enough for the purposes of analysing and dating the zodiac in question. We shall reproduce these copies below.

The Long Zodiac of Dendera also survived in its entirety. There are no traces of damage on the copies from the Napoleonic edition.

3) The zodiac from the Greater Temple of Esna. A ceiling relief carved in stone. [1100] contains a shaded copy and a drawn copy of the zodiac, qv in [1100], A. Vol. IV, Pl. 79.

The zodiac from the Greater Temple of Esna is of the rectangular type; therefore, everything that has been said about the Long Zodiac of Dendera above applies to this zodiac as well.

According to the drawing in the Napoleonic edition ([1100]), the zodiac had been in a very good condition when it was copies, with no missing details. The copy in [1100] is a detailed and an accurate one. However, the hieroglyphic inscriptions on the plaques weren't copied – or had possibly already been lost by the time the copy was made.

4) The zodiac from the Lesser Temple of Esna. A ceiling relief carved in stone. [1100] also contains a drawn and a shaded copy of the zodiac. A part of the zodiac had been chiselled off, which is how it was drawn by Napoleon's artists. The remaining part is in good condition.

5) The zodiac from the ceiling of the sepulchre in the Valley of the Kings near Luxor. In the Napoleonic description as given in [1100], the sepulchre is called "*1er tombeau des Rois à l'Ouest*". [1100] also contains a detaild copy of the zodiac in colour, qv in fig. 12.3. The zodiac is of the rectangular type without too many small details. The drawing from [1100] suffices for the purpose of analysing the zodiac and dating it astronomically.

6) Modern drawn copies of the Round Zodiac of Dendera and its fragments made from the original of the zodiac kept in the Louvre ([1062]).

7) 30 photographs of the Round Zodiac of Dendera that Professor Y. V. Tatarinov (MSU) had made for us in the Louvre in the year 2000 ([1062]).

8) Photographed fragments of the Round Zodiac of Dendera from the ***Art and History of Egypt*** by Alberto Carlo Carpiceci ([370], page 165).

9) Photographed fragment of the Round Zodiac of Dendera from the ***Life and Death of the Pharaoh Tutankhamen*** by Christiane Desroches-Noblecourt ([1101], page 255).

10) A drawn copy of the zodiac discovered by H. Brugsch on an "ancient" Egyptian coffin. Published by H. Brugsch in 1862 ([1054]). Brugsch's drawn copy is reproduced by N. A. Morozov in [544], Volume 5, page 696.

11) A drawn copy of the horoscopes of Athribis discovered by Flinders Petrie on the ceiling of an Egyptian burial cave in 1901 which he published in the 14th volume of the ***British School of Archaelogy in Egypt,*** which is whence N. A. Morozov borrowed it ([544], Volume 6, pages 728 and 739. See also [1340:1].

12) Zodiacs from the ceilings of the Egyptian sepulchres of Petosiris and Petubastis. Black and white photographs and colour photographs of some fragments taken from the publication by Neugebauer, Parker and Pingrie ([1291]).

13) A copy of the Long Zodiac of Dendera published by Baudet and reproduced by N. A. Morozov in ([544], Volume 6, inset after page 672).

6. STYLISTIC CHANGES IN THE ZODIACS FROM THE NAPOLEONIC EGYPTIAN ALBUM

One has to point out the following in re the copies of Egyptian zodiacs in the Napoleonic edition ([1100]).

Napoleon's artists were aspiring to achieve high precision in the allocation of the zodiacal figures that would be close to photographical. They would copy everything they could make out, even the minute details. However, they also introduced stylistic alteration into the appearance of the figures, making the

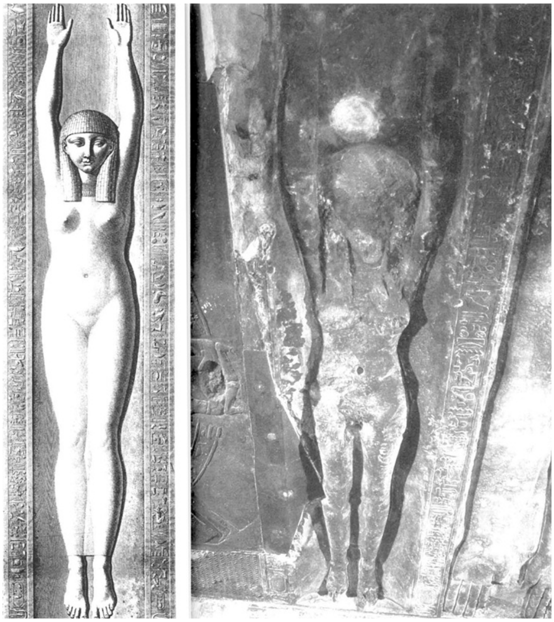

Fig. 12.28. A figure of the celestial symbol – the goddess Nuit near the Round Zodiac of Dendera (DR) according to the Napoleonic copy (left), and a modern photograph of the original (right). The drawing is an approximated one, although the position of the figure is copied with precision. Drawing taken from [1100], A. Vol. IV, Pl. 21. The photograph is from [370], page 165.

latter more elegant and refined, as though applying the style and technique of their epoch to the drawings of the Egyptian zodiacs. Thus, the drawings from the Napoleonic album cannot be treated as photographs – in particular, they cannot serve as basis for an opinion concerning the artistic level of the Egyptian zodiacs. A comparison with the photographs demonstrates that the real zodiacs from the temple of Dendera are a lot more primitive and much rougher than they look on the drawings of the Napoleonic artists. The same must be true for the zodiacs of Esna – however, we do not have photographs of those at our disposal and therefore couldn't compare them to the drawings from the Napoleonic publication.

In fig. 12.28 one sees two drawings of the Goddess Nuit from the Dendera Temple (neighbouring the Round Zodiac) presented for comparison. The first one comes from the drawing made by the Napoleonic artists ([1100], A. Vol. IV; Pl. 21), and the second – from a modern photograph ([370], page 165). One instantly notices the rather serious stylistic alteration inherent in the Napoleonic drawing inasmuch as the figure of Nuit is concerned; at the same time, the position of her body was copied with the utmost care. Let us point out that, unlike the original where Nuit is drawn naked, she ended up wearing a transparent

Fig. 12.29. Fragment of the Round Zodiac (DR) according to the Napoleonic copy (left) and a modern photograph of the original (right). The copy is correct, but some of the figures are approximated to a great extent, especially the faces. Drawing taken from [1100], A. Vol. IV, Pl. 21. The photograph is from [370], page 255.

Fig. 12.30. Fragment of the Round Zodiac of Dendera (DR). The precise modern drawn copy is on the left ([1062], page 71). In the middle we see the drawn copy made by the Napoleonic artists, and their shaded copy is on the right. The Napoleonic drawings reflect the disposition of figures erroneously – namely, the wayfarer with the rod stopped touching Virgo's ear of wheat with his feet, as is the case in the original. Furthermore, the three hieroglyphs over the wayfarer's head transformed into a single undulated body of a serpent. Taken from [1062], page 71; see also [1100], A. Vol. IV, Pl. 21.

Fig. 12.31. Fragment of the Round Zodiac (DR). Photograph of the region around the constellation of Virgo. Taken from [370], page 165.

Fig. 12.32. Drawn copy of a fragment of the Round Zodiac (DR). Wayfarer with a rod standing over Virgo's ear of wheat. We see three hieroglyphs over the head of the wayfarer – "walk" (foot), "fabric" (bend) and "knife" (semicircle with a handle), forming the inscription saying "SBK" ([370], page 19). Taken from [1062], page 29.

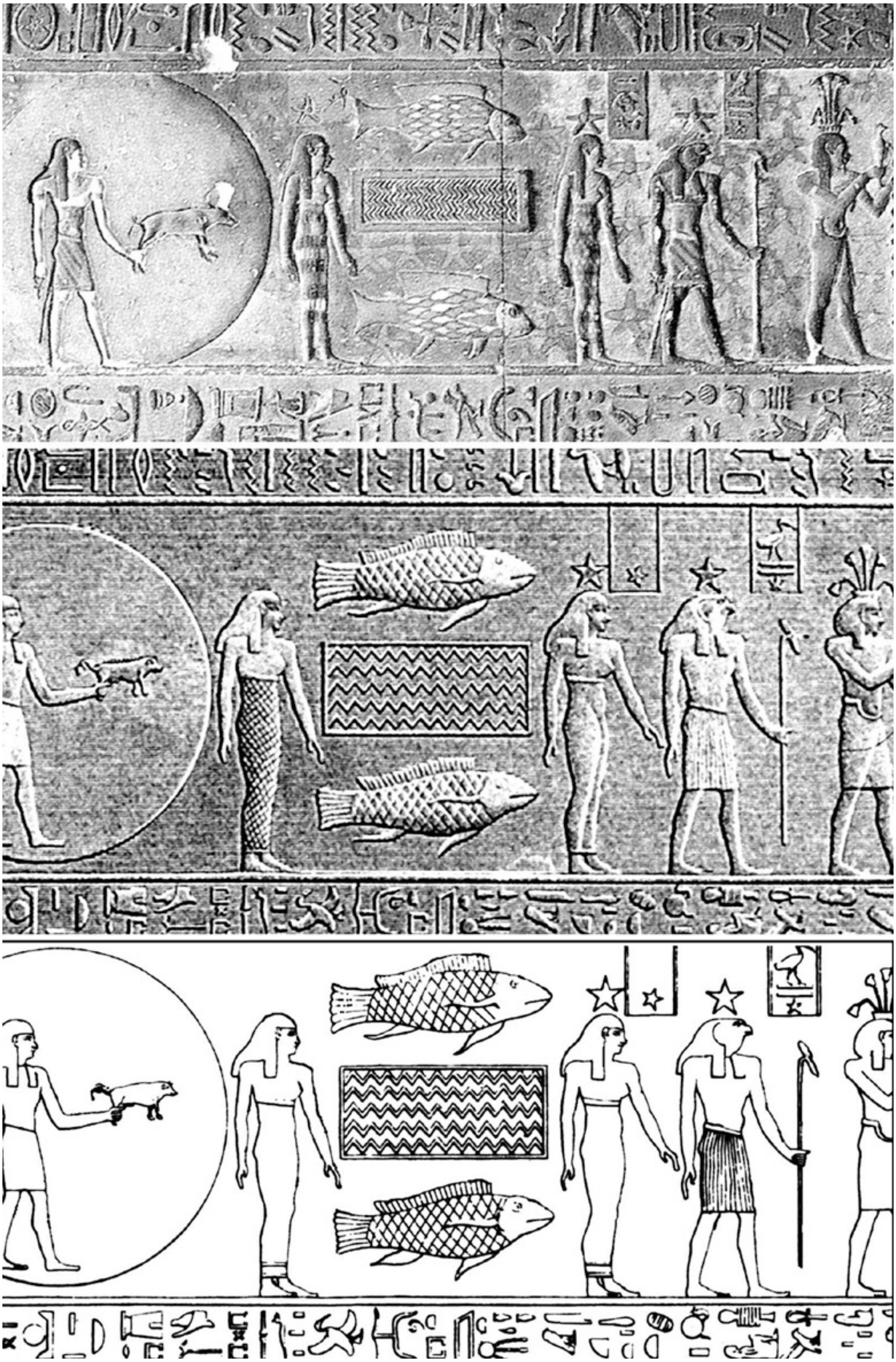

Fig. 12.33. The Long Zodiac of Dendera (DL). One and the same fragment according to the modern photograph of the original (top), the Napoleonic shaded copy (middle) and drawing (bottom). The Napoleonic copies are precise enough; however, certain minor details are either lost or approximated. Taken from [1062], page 37, and [1100], A. Vol. IV, Pl. 20.

dress on the drawing – however, the artists apparently tried to make the dress that they had added as unobtrusive as possible. The face of Nuit also appears to be a fruit of the artists' fantasy since on the photograph one can only see a general contour of a human face, which was either chiselled off, or left unfinished initially.

In fig. 12.29 one can see the same fragment of the Round Zodiac of Dendera as presented according to the Napoleonic drawing ([1100], A. Vol. IV; Pl. 21) and a modern photograph ([1100], page 255). The drawing is precise enough, yet one sees that some of the figures underwent a stylistic transformation. First and foremost, it concerns the faces which are done a lot more accurately than in the original. The Egyptian relief contains rather generalized outlines of faces – all one manages to see is the kind of head a given figure has – human, falcon's, lion's etc. The faces of the figures on the drawing are a lot more handsome than the sketchy original. However, despite the embellishments such as drawn eyes etc, the artists were careful not to distort the meaning of the original (see fig. 12.29).

In fig. 12.30 one sees that in certain cases the details of mutual figure disposition on the Round Zodiac of Dendera were lost by the Napoleonic artists, since it is next to impossible to attain photographic precision with nothing but the naked eye for a composition this complex. In fig. 12.30 one sees one and the same fragment of the Round Zodiac in its three versions: 1) modern drawn copy from [1062] – most probably copied from a photograph; 2) the "Napoleonic" drawn copy from [1100], and 3) the "Napoleonic" shaded drawing from [1100]. A photograph of this part of the Zodiac can be seen in fig. 12.31. It is visible that the modern drawn copy from [1062] is the most precise of all. Upon it we see a figure of a wayfarer who's standing upon Virgo's Ear of Wheat (or touching it with his foot, at least, qv in the picture), in the exact same manner one sees it on the Zodiac itself. *Cf.* the photograph in fig. 12.31. However, in both Napoleonic drawings, shaded as well as drawn, this figure is at a considerable distance from Virgo's Ear of Wheat.

As we shall see below, the error of Napoleon's artists is far from harmless. Let us expound it – the matter is that the wayfarer on the zodiac symbolizes a planet, whereas the ear of wheat in the hand of Virgo in fig. 12.30 is Spica, the brightest star in the constellation of Virgo. The fact that the wayfarer (planet) touched Spica (Virgo's Ear of Wheat) probably means a superimposition of the planet over a star, or a very close proximity between the two. Bear in mind that Spica is located extremely close to the ecliptic plane, and so planets can really approach this bright and famous star and even become invisible outshone by it.

Apart from that, the hieroglyphic inscription over the head of the wayfarer (above the asterisk) was transformed into a coiled snake by the Napoleonic artists. However, in reality it isn't a snake but rather three hieroglyphs: "to walk" (foot), "fabric" (bend) and "knife" (semi-circle with a handle) comprising the inscription SBK ([370], page 19). See figs. 12.31 and 12.32. We are most likely to be seeing the old name of Mercury here – namely, "Sebek". This is how Mercury is referred to in the Egyptian zodiacs, according to the prominent XIX century Egyptologist, Heinrich Brugsch (see [544], Volume 6, page 697). We shall come back to this inscription below, in CHRON3, Chapter 17.

Thus, what we observe in the present example is the loss of important astronomical information bearing direct relation to the deciphering and dating of the Round Zodiac of Dendera from the Napoleonic drawings. Furthermore, this information also became distorted. Fortunately, this case is an exception rather than a rule. In general, the "Napoleonic" drawings are sufficiently precise – however, they do contain distortions, and we have just discovered that such distortions may concern the really important details of the zodiac.

In fig. 12.33 we see a photograph of a fragment of the Long Zodiac as compared to the Napoleonic drawing and shaded drawing of the same fragment. One sees the copies to be precise in general, although some of the smaller details differ. It concerns the stylistic alterations of how the figures look on the drawing. Apart from that, on the "Napoleonic" drawings both female figures are wearing long dresses, which look completely different on the photograph. A number of small details got lost, which can be observed quite well in the photographic close-up of a fragment of a Long Zodiac's picture, qv in fig. 12.34. It is easy to observe that the original was represented well by the Napoleonic artists; however, it has to be said that they missed on some of the important details – in the

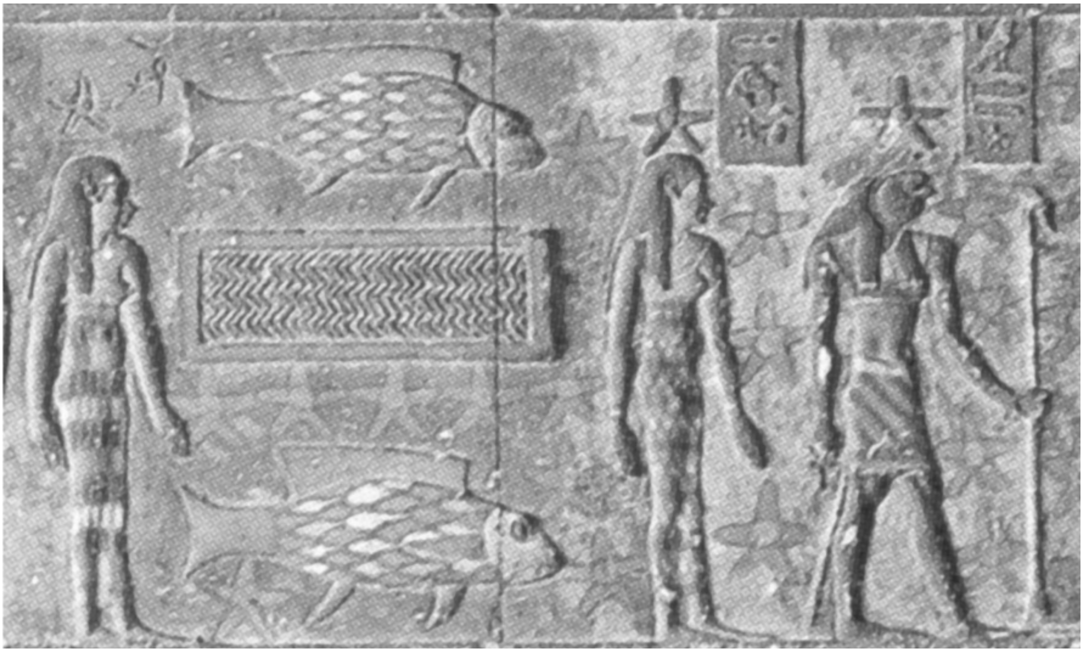

Fig. 12.34. Fragment of the Long Zodiac (DL) as seen on the modern photograph of the original. The same fragment from Napoleonic copies can be seen in fig. 12.33. Only the minor details differ: 1) the falcon head in the left tablet is omitted; 2) the semi-obliterated star over the head of the young woman on the left is also omitted; 3) the falcon from the right table transformed into an ibis; 4) there is no cross in the hand of the male figure; 5) the figures and especially the dresses of the young women are approximated. Photograph taken from [1062], page 37.

following area of the Long Zodiac of Dendera, for instance:

1) The falcon's head in the table above the head of the girl on the right is omitted, qv in fig. 12.34.

2) The star on the left of the girl's hat also became omitted due to its regrettable general condition, qv in fig. 12.34.

3) The bird in the table above the head of the male figure on the right is a falcon, and the drawing transforms it into an ibis (see fig. 12.34).

4) The Egyptian cross which one sees in the hand of the male figure on the photograph (fig. 12.34), is absent from the drawings (cf. fig. 12.33).

5) The shapes and especially the garments of the girls are afflicted by stylistic embellishment to a great extent (qv in fig. 12.34)

However, let us reiterate that all such omissions from the Napoleonic catalogue ([1100]) only pertain to individual details of drawings. In general, one has to acknowledge the fact that the Napoleonic copies of the Egyptian zodiacs represent the original with sufficient precision and can be used in order to decipher the Egyptian zodiacs and date them astronomically, albeit with a certain amount of care. One has to bear in mind that semi-obliterated details of the original on the Napoleonic drawings would occasionally go missing. Apart from that, the artwork on the Napoleonic copies of Egyptian zodiacs has been given a distinct XVIII-century look.

7. THE NAMES WE USE FOR THE EGYPTIAN ZODIACS

Occasionally, we shall find it convenient to use abbreviations in order to refer to Egyptian zodiacs. We shall be using the following indications that consist of two Roman letters for each zodiac:

1) *DL* – the Long Zodiac of Dendera;

2) *DR* – the Round Zodiac of Dendera;

3) *EB* – the zodiac from the Greater Temple in Esna;

4) *EM* – the zodiac from the Lesser Temple in Esna;

5) *AV* – the Upper Athribis Zodiac of Flinders Petrie;

6) *AN* – the Lower Athribis Zodiac of Flinders Petrie;

7) *OU* – the Theban colour zodiac from the Luxor Valley of the Kings;

8) *P1* – the zodiac from the sepulchre of Petosiris, external chamber;

9) *P2* – the zodiac from the sepulchre of Petosiris, inner sanctum;

10) *BR* – the Zodiac according to Brugsch.

In particular, these indications will be used on pictures and graphs, and also for referring to computer calculations. Furthermore, they partially constitute the names of the files that we cite in the Annexes.

Most of the Zodiacs listed herein have already been mentioned briefly above. We shall deal with each of them more specifically in the sections concerning the astronomical dating.

Should some Egyptian zodiac have failed to enter the abovementioned list, it is for one of the following reasons: the zodiac in question contains no horoscope, or that we haven't got sufficiently detailed representations.

CHAPTER 13

Former astronomical datings of the Egyptian zodiacs

1. THE ROUND AND THE LONG ZODIAC OF DENDERA

First attempts to date the Round and Long Zodiacs of Dendera date to the XIX century. The initial interpretation of their horoscopes had been suggested by the XIX century Egyptologists – in particular, the famous German Egyptologist H. Brugsch. The interpretation was based on the appearance of the figures depicted on the zodiacs as well as the hieroglyphic inscriptions over the head of some planetary figures. See [544], Volume 6, pages 652-655 for a detailed overview.

In particular, it was instantly pointed out that all the planets except for the Sun and the Moon are represented as wayfarers carrying rods on the zodiacs of Dendera as well as many other Egyptian zodiacs (see [544], Volume 6, page 652). The rods symbolized planetary motion across the sphere of the immobile stars. Planets were considered to be "mobile" or "wandering" stars in ancient astronomy – indeed, the very Greek word *planetes*, or "vagrant" ([393], page 40). Therefore, it is hardly surprising that the planetary figures on Egyptian zodiacs are usually equipped with rods; see more on this subject below, in the sections related to the astronomical symbols of Egyptian zodiacs.

The Sun and the Moon were represented as circles on Egyptian zodiacs, often containing figures ([544], Volume 6, pages 652-655). This is how they're represented on the zodiacs of Dendera.

The initial interpretation of the Dendera zodiacs offered by the Egyptologists was subsequently corrected by Morozov (see [544], Volume 6, pages 651-672). In particular, Morozov had corrected Brugsch's erroneous identification of Venus; we shall discuss this in more detail below.

Many renowned astronomers of the XIX century (such as Dupuis, Laplace, Fourier, Letron, Holme, Biod et al). Their result proved negative – there were no planetary combinations (or horoscopes) resembling those from Dendera anywhere on the real sky over the entire period between deep antiquity and the III century A.D., or up until the very Middle Ages ([544], Volume 6, page 651). There had been no calculations conducted at any latter point up before the research of N. A. Morozov.

N. A. Morozov employed his fundamental knowledge of the ancient astronomical symbols in order to verify the interpretation of the Dendera zodiacs as offered by the Egyptologists. In several cases – such as the abovementioned case of Venus, he corrected some of the obvious errors inherent said interpretations. Yet he did confirm the correctness of how the

zodiacs were deciphered by the Egyptologists for the most part. The amended interpretations of the Dendera zodiacs in Morozov's rendition are discussed at great length below.

The approach to the deciphering of the Egyptian zodiacs that was chosen by N. A. Morozov had been classical, the same as suggested in the works of the XIX century Egyptologists, which is why his interpretation had remained incomplete. Our research demonstrates that he ignored or misinterpreted a great deal of astronomical data contained by the Egyptian zodiacs apart from the horoscope. The reason is that Morozov, likewise his predecessors, had been of the false opinion that the astronomical content of an Egyptian zodiac is exhausted by the horoscope contained therein.

Having verified and corrected the interpretations of the Dendera zodiacs, N. A. Morozov started to calculate the datings of their horoscopes. Unlike his predecessors, he knew better than to trust the Scaligerian chronology and the "ancient" Egyptian chronology thereby implied. Therefore Morozov carried on with his calculations for epochs postdating the III century A.D., coming up with what can only be considered a spectacular solution in comparison to all the results of his predecessors:

The Long Zodiac of Dendera:
6 May 540 A.D.
The Round Zodiac of Dendera:
15 March 568 A.D.
(N. A. Morozov, [544], Volume 6, pages 689-691.)

The calculations made by N. A. Morozov for the zodiacs of Dendera were verified by the famous astronomer N. I. Idelson, who had performed control calculations of his own, confirming Morozov's correctness ([544], Volume 6, page 669).

Tables containing N. A. Morozov's interpretations of the Dendera zodiacs and the results of N. I. Idelson's control calculations are presented in figs. 13.1 and 13.2. Both tables were borrowed from N. A. Morozov's book ([544], Volume 6).

Morozov proved the first to have solved the "Dendera problem" in such a way that would be satisfactory from the astronomical point of view.

The solution of N. A. Morozov is based on the interpretation of the Dendera zodiacs that he had used for the purpose, which makes his astronomical dating of the Dendera zodiacs to the VI century the only one possible on the entire interval between 964 B.C. and 1303 A.D. This is the time interval considered in N. A. Morozov's calculations ([544], Volume 6, page 667).

However, N. A. Morozov's solution was far from ideally strict. It contained a number of imprecise postulations that seemed minute, but proved to affect the end result to a substantial extent. Namely:

1) The figure of Venus on the Long Zodiac is place between the Zodiacal symbols of Aries and Taurus. In Morozov's solution Venus is located between Aries and Pisces, which places it on the opposite side of Aries.

2) According to how N. A. Morozov himself deciphers the Long Zodiac, Mercury was to the west from the Sun, between Aries and Taurus. However, in Morozov's solution Mercury had been to the east from the Sun, between Taurus and Gemini, contrary to the zodiac's indications.

3) On the Long Zodiac we see no star above the head of Mercury, which implies that Mercury wasn't visible for sunrays, according to Morozov himself. However, in his solution Mercury proves to be plainly visible on the celestial sphere.

This is the commentary of N. S. Kellin and D. V. Denisenko: "The most difficult thing is to explain why Mercury, which was located 15-17 degrees to the east of the Sun on 6 May 540, is placed to the west of the sun, at so short a distance that it makes the planet invisible due to solar luminosity, which is confirmed by the absence of a star over Mercury's head. Yet at the distance of 15 degrees away from the Sun one can even see Mercury from the latitude of Moscow, let alone Egypt, where the angle between the ecliptic and the horizon is greater" ([376]).

Let us reiterate that the absence of a star over the head of a planetary figure implied the invisibility of said planet in the zodiacs of Dendera, as N. A. Morozov himself pointed out on a number of occasions. In other words, the planet would be too close to the Sun that day and hence impossible to see. On the other hand, the presence of a star over the head of a planetary figure would mean that the planet in question was visible that day ([544], Volume 6, pages 675, 678 and 679).

Дата 568 г. 15 марта, координаты 1900 г.

Сатурн	198°1	(Дева, ближе к Весам, как и показано двумя фигурами, одна под Девой, а другая сзади Девы, впереди Весов).
Юпитер	135°0	(Рак, ближе ко Льву, вполне удовлетворительно: одна фигура под Раком, а другая над Раком, ближе ко Льву).
Марс	302°3	(Козерог, как показано двумя фигурами над головой и на спине Рака).
Венера	36°1	(Овен, около средины, как и показано парочкой женских путниц под Овном).
Меркурий	5°0	(Рыбы, около средины Рыб, но благодаря тому, что средина уже замещена Солнцем, Луной и знаком равноденствия, Меркурий поставлен по неволе впереди, ближе к Водолею, как и было).
Солнце	16°44	(Рыбы, около средины, как и показано кружком над Рыбой, с глазом посредине его).
Луна		Рыбы, как и показано.

The date: 15 March 568. Coordinates for 1900 A.D.

Saturn	198° 1	(Virgo, closer to Libra as shown by the two figures – one underneath Virgo, and the other behind it and in front of Libra).
Jupiter	135° 0	(Cancer, closer to Leo – quite satisfactory: one of the figures is underneath Cancer, and the other – above the latter, closer to Leo).
Mars	302° 3	(Capricorn, as demonstrated by the two figures over the head and on the back of Cancer).
Venus	36° 1	(Aries, near the middle, as shown by the pair of female wayfarers underneath Aries).
Mercury	5° 0	(Pisces, near the middle; however, due to the fact that the middle is already occupied by the Sun, the Moon and the equinox symbol, Mercury had to be placed in front, closer to Aquarius, which is indeed the case).
The Sun	16° 44	(Pisces, near the middle, as indicated by the circle over the fish symbol with a circle in the middle).
The Moon		Pisces, as demonstrated.

Fig. 13.1. The Round Zodiac of Dendera (DR). N. A. Morozov's decipherment and the planetary positions in constellations for the date of Morozov's solution – 15 March 568 A.D. Control calculations by N. I. Idelson. Planetary longitudes are given in relation to the spring equinox point for the epoch of 1900. Table taken from [544], Volume 6, page 669.

	Совр. долготы.
Сатурн	212°0 (Дева у Весов)
Юпитер	23°1 (Рыбы у Овна)
Марс	18°8 (Рыбы)
Венера	33°7 (Овен)
Меркурий	90°6 (Между Тельцом и Близнецами)
Солнце	76°3 (Телец у Близнецов)
Луна	в Весах.

	Modern longitudes.
Saturn	212° 0 (Virgo near Libra)
Jupiter	23° 1 (Pisces near Aries)
Mars	18° 8 (Pisces)
Venus	33° 7 (Aries)
Mercury	90° 6 (between Taurus and Gemini)
The Sun	76° 3 (Taurus near Gemini)
The Moon	in Libra.

Fig. 13.2. The Long Zodiac of Dendera (DL). N. A. Morozov's interpretation and the planetary positions in constellations for the date of Morozov's solution – 6 May 540 A.D. Control calculations by N. I. Idelson. Planetary longitudes are given in relation to the spring equinox point for the epoch of 1900. Table taken from [544], Volume 6, page 687.

4) In the Round Zodiac we see a star over Mercury's head, signifying the planet's visibility. In Morozov's solution, Mercury is too close to the sun to be visible, qv in fig. 13.1.

Bear in mind that the visibility of stars and planets requires the Sun to be at some 9-10 degrees under the horizon, while in Morozov's solution for the Round Zodiac the Sun had been at a mere 4-6 degrees below the horizon when Mercury rose at the latitude of Egypt, Mercury's luminosity equalling +0.4 on the photometric scale.

On the latitude of Moscow, for instance, the Sun and Mercury had risen at the same time that day; therefore, on the 15 March 568 A.D. (Morozov's dating for the Round Zodiac) Mercury's invisibility is known a priori (cited values were calculated with the aid of the Turbo-Sky software).

The Muscovite physicists N. S. Kellin and D. V. Denisenko had studied Morozov's solution meticulously in the early 1990's ([376], pages 315-329). They wrote the following on the subject: "N. A. Morozov's solution for the Long Zodiac contains several incon-

sistencies and can therefore be called an arbitrary one" ([376], page 323).

N. S. Kellin and D. V. Denisenko carried on with N. A. Morozov's studies in the field of the astronomical dating of the Dendera zodiacs ([376], pages 315-329). As we already mentioned, N. A. Morozov only covered the epoch until 1303 in his calculations. Kellin and Denisenko widened that interval to include all the epochs up until the present age. They were using the same interpretation of the Dendera zodiacs as N. A. Morozov, trusting him completely in this respect.

However, unlike N. A. Morozov, N. S. Kellin and D. V. Denisenko were able to use a computer for their calculations. As a result, another solutions for the zodiacs of Dendera as deciphered by N. A. Morozov was found:

The Long Zodiac of Dendera:
12 May 1394 A.D.
The Round Zodiac of Dendera:
22 March 1422 A.D.
(N. S. Kellin and D. V. Denisenko, [376], pages 315-329.)

The solution offered by Kellin and Denisenko turned out even better than Morozov's – for both zodiacs, the Round and the Long ([376], pages 321-325). However, their solution for the Round Zodiac did in fact contain a certain error, which made the authors write the following: "We are aware of the fact that our version is also far from ideal, and therefore this solution for the Long Zodiac [the 1394 solution – Auth.] is also an arbitrary one, although it is admittedly more satisfactory than the one found by N. A. Morozov" ([376, page 325).

Thus, there was no ideal solution found for the zodiacs of Dendera in strictly Morozovian interpretation – indeed, it turns out that there is no such solution.

In 1999-2000 the problem of astronomical datings of Egyptian zodiacs (the ones from Dendera in particular) was confronted by T. N. Fomenko ([METH3]:3, Chapter 12). She analyzed Morozov's interpretation once again and suggested to amend it somewhat; in particular, her work proposed to swap the solar and lunar symbols in the Morozovian version of deciphering the Round Zodiac.

T. N. Fomenko suggested that the eye in the circle that N. A. Morozov had considered the Solar symbol was really the Moon, and vice versa – the young woman in the circle that Morozov deemed to represent the Moon refers to the Sun according to T. N. Fomenko. We shall not linger upon the discussion of this issue since we shall come back to it below, in CHRON3, Chapter 15. We consider both versions in our work.

T. N. Fomenko discovered another important fact that she relates in [912:3]. It turns out that the drawn copy of the Long zodiac from Bode's ***Uranography*** that was used by N. A. Morozov ([544], Volume 6, pages 674 and 746-748) contains several substantial distortions ([912:3], pages 746-748). Having compared this copy (as reproduced by N. A. Morozov) to the much more precise copy from the Napoleonic album ([1100]), T. N. Fomenko noticed that the distortions were great enough to alter the astronomical content of the Long Zodiac. This renders the horoscope calculated by N. A. Morozov who had used the copy in question for reference to be an erroneous one. We cite a copy of the Long Zodiac from Bode's ***Uranography*** as used by Morozov and reproduced in his book ([544], Volume 6, inset after page 673) in figs. 13.3 and 13.4. The first publication of this drawing was made in the ***Voyage dans la Basse et la Haute Egypt*** by Baron D. V. Denon dating to 1802. Baron Denon had accompanied Napoleon during the Egyptian expedition of 1798 and made many drawings of Egyptian antiquities that were subsequently published in his book. Many of these drawings were made in a hurry, virtually under enemy fire ([1378:1]). They would naturally contain errors. Later on, Denon edited the Napoleonic Egyptian album ([1100]) where the drawing of the Long Zodiac was a lot more correct and accurate than the first one. However, Morozov appears to have been unaware that a precise drawn copy of the Long Dendera Zodiac existed in the Napoleonic album and used the initial inaccurate copy by Denon that was reprinted in Bode's ***Uranography.***

T. N. Fomenko wrote the following in this respect: "He [N. A. Morozov – Auth.] had trusted this drawing completely, and got down to deciphering the Long Zodiac 'according to Bode'. However, he had instantly encountered problems which he never managed to solve … Let us study Bode's drawing more attentively. One instantly notices that the actual figure on the left that represents the planet Saturn, as we already know,

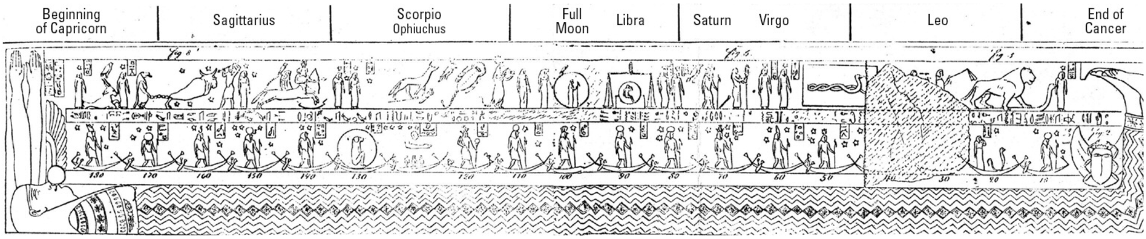

Fig. 13.3. Long Zodiac of Dendera (DL). A drawing from the ***Uranography*** by Bode as used by N. A. Morozov. The names of constellations and other indications were added by N. A. Morozov. Taken from [544], Volume 6, inset between the pages 671 and 672. First part of the drawing.

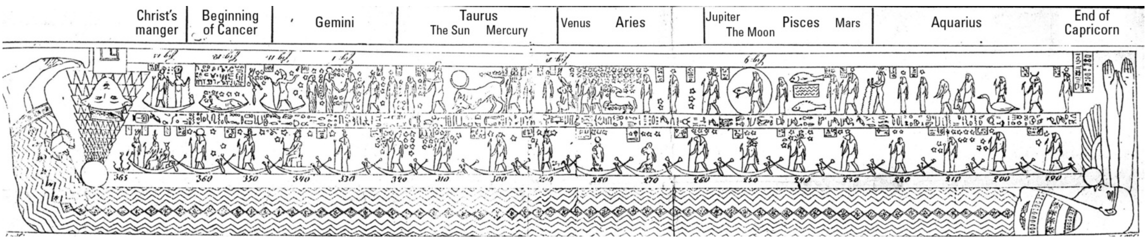

Fig. 13.4. Long Zodiac of Dendera (DL). A drawing from the ***Uranography*** by Bode. Second part of the drawing. Taken from [544], Volume 6, inset between the pages 671 and 672.

is drawn without a rod for some reason … Bode's drawing thus 'writes Saturn out' of this part of the Long Zodiac … however, for some reason the astronomer Bode does the contrary to the area between Libra and Virgo, adding a rod to one of the figures … we see nothing of the kind on either copy of the Napoleonic artists. Figures in this part of the Zodiac have no rods … as a result, N. A. Morozov, deceived by this fragment of Bode's drawing, placed the planet Saturn here. This proved to be erroneous" ([912:3], page 737).

In order to make the reader capable of estimating the difference between the two copies of the Long Zodiac of Dendera, we reproduce the same fragment of the zodiac as taken from the two sources mentioned above. One can plainly see that in Denon's drawing from the ***Uranography*** the female figure with a crescent on her head, apart from holding the rod that she isn't supposed to hold (which ascribes the planet qualities it does not possess in the Long Zodiac), is altogether transformed into a male for some reason, qv in fig. 13.5. A propos, it is this very figure that Morozov considered to represent Saturn because of the erroneously drawn rod.

T. N. Fomenko used the rather precise and accurate copies of the Long Zodiac of Dendera from the Napoleonic album ([1100]) in order to correct the errors in Morozov's interpretation that stemmed from the inaccuracy of the illustration found in the ***Uranography,*** and suggested a new interpretation of the Long Zodiac. See [912:3] for explanations of this interpretation.

The search for astronomical datings of Egyptian zodiacs in T. N. Fomenko's work ([912:3]) was performed with more exacting solution conditions than previously; these conditions can be related as follows.

1) One had to ensure perfectly strict correlation of how the planets were distributed across the Zodiacal constellations to the parameters specified in the zodiac under study.

2) The order of planets had to be adhered to scrupulously. This condition was absent from earlier works, and its first formulation can be found in [912:3].

Solutions which did not satisfy to the above conditions were rejected ([METH3]:3, Chapter 12).

Thus, the conditions for the astronomical solutions as applied to the Zodiacs the way they were for-

mulated in T. N. Fomenko's work ([912:3]) happened to be a great deal more demanding than it was the case with the works by Morozov and even Kellin-Denisenko.

One could say that T. N. Fomenko was the first to demand ideal correspondence between the calculated planetary positions and their location on the Egyptian zodiac (considering the indications she used and in accordance to the interpretation offered in her work). Unlike the approach of Morozov and Kellin-Denisenko, the work of T. N. Fomenko allowed for no "arbitrary" solutions.

This new idea proved extremely useful for the analysis of the Egyptian zodiacs. We fully follow it in our research.

However, T. N. Fomenko did not account for the presence or absence of stars over the heads of planetary figures from the Dendera zodiacs.

Let us remind the reader that, according to N. A. Morozov, a star over the head of a planetary symbol on the Dendera zodiacs is an indication of this planet's visibility; in other words, it is a sign that the planet in question could be seen with the naked eye at dawn or at dusk. On the other hand, the absence of stars near planetary figures (at least the ones drawn within immediate vicinity of the Sun) means that the planet in question was not visible on the date ciphered in the horoscope, according to [544], Volume 6, pages 675, 678 and 679). For the planets located at a certain distance from the Sun, the star sign could be omitted since the very distance between the Sun and the planet in question would testify to the visibility of the planet in question on the sky. We shall come back to this issue below.

Indications of a planet's visibility or a lack thereof are of the utmost importance for Venus and Mercury; they are close to the Sun, and become invisible due to solar rays every now and then. If one of these planets is specified as visible on the zodiac and it isn't such in the calculated solution or vice versa, the solution in question has to be rejected (naturally, on the condition that we interpret the planetary visibility symbols from the Egyptian zodiac correctly).

To jump ahead, let us mention that our approach to the problem of planetary visibility signs on the Egyptian zodiacs is as follows. One has to bear in mind that it is the furthest thing from obvious a priori which author was correct – N. A. Morozov in his presumption that Egyptian zodiacs contain indications of planetary visibility, or T. N. Fomenko who did not account for such indications in [912:3].

Therefore, we shall tentatively consider Morozov's hypothesis to be correct and account for it in our attempts to find such solutions for the Egyptian zodiacs that we know as would conform to the following specifications:

Primo, they have to be ideal according to T. N. Fomenko's stipulations, which imply strict correspondence to the Egyptian zodiac inasmuch as planetary dispositions in constellations and their respective order are concerned.

Secundo, Morozov's visibility indicators must also be taken into account.

However, the stipulations do not end here, and also include rigid correspondence to all the additional astronomical information that we found on the Zodiacs.

However, we shall not just consider the "best" Zodiacal interpretation, but all of them at once.

If one really finds such solutions for the Egyptian zodiacs (ones that will be ideal in every sense as described above), it will mean that N. A. Morozov had been correct in this particular instant, which indeed proves to be the case, according to the results of our

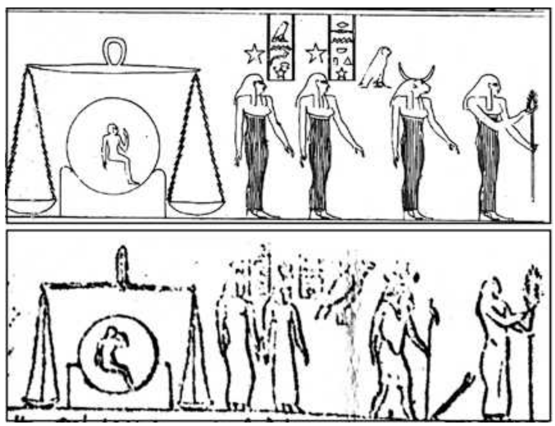

Fig. 13.5. Long Zodiac of Dendera (DL). One and the same fragment according to the Napoleonic drawing (top) and the poor-quality drawing from the ***Uranography*** by Bode as used by N. A. Morozov (bottom). Taken from [1100], A. Vol. IV, Pl. 20 (top fragment) and [544], Volume 6, inset after page 673 (bottom fragment).

calculations. N. A. Morozov's opinion on the visibility criterion was confirmed fully, qv below, in the sections related to the dating of actual zodiacs.

Let us return to T. N. Fomenko's work ([912:3]). Above we have given a brief account of the approach to the dating of Egyptian zodiacs used in the present book; it is rendered in more detail in ([912:3]).

The solution found for the Long Zodiac by T. N. Fomenko in [912:3] is the only one for the historical interval as seen in the framework of the general approach to the dating of the Egyptian zodiacs and the interpretation of the latter that she suggests, namely, 7-8 April 1727. As for the Round Zodiac, its dating did not change as compared to the datings suggested by Morozov and Denisenko/Kellin.

The reason for this last coincidence is that, despite the fact that the different interpretations given by N. A. Morozov and T. N. Fomenko make the signs for the Sun and the Moon swap places, both these signs are nevertheless located in the same constellation, namely, Pisces, qv in fig. 13.6. Therefore, the horoscope and hence the dating of the Round Zodiac remain unaltered when we swap the solar symbol with the lunar.

Thus, the solution of T. N. Fomenko is as follows:

The Long Zodiac of Dendera:
7-8 April 1727 A.D.
(Our final dating of 22-27 April 1168 A.D. was also among the results, but got rejected due to insufficient decipherment precision.)
The Round Zodiac of Dendera:
15 March 568 A.D.
(T. N. Fomenko, [912:3].)
(The dating of 30-31 March 1185 A.D., which is close to our final dating, was also among the results, but got rejected due to insufficient decipherment precision.)

Our study of the Dendera zodiacs demonstrated that, apart from the primary horoscopes considered in the abovementioned research, they contain rather detailed horoscopes of a more special nature. These yield additional astronomical information that gives us the opportunity to calculate all possible interpretation versions simultaneously. Such volume of extra data renders the chance of a random solution almost nonexistent. We shall consider this in more detail below. We shall merely refer the reader to the reproductions of both zodiacs where we point out the groups of symbols that contain astronomical information that supplements the primary horoscopes and allows for a more precise dating, qv in figs. 13.7 and 13.8. As one can see, there is a substantial amount of such symbols here.

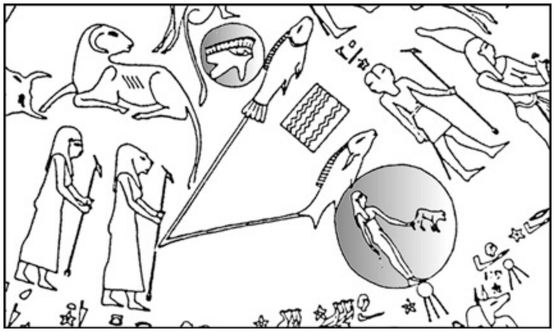

Fig. 13.6. Round Zodiac of Dendera (DR). The discrepancy between the interpretations of N. A. Morozov and T. N. Fomenko. We see two highlighted circles in the constellation of Pisces – one of them contains an eye, and the other – a figure of a young woman. N. A. Morozov was of the opinion that the circle with the eye stands for the Sun, and the circle with the young woman represents the Moon. T. N. Fomenko suggests the reverse interpretation. Drawn copy from [1062], pages 9 and 71.

See the description of the in-depth analysis, interpretation and dating of the Dendera zodiacs as performed according to our method below. The astronomical solution that we came up with for the Dendera zodiacs is the only one for the entire historical interval between 500 B.C. and the present epoch; it is as follows:

The Long Zodiac of Dendera:
22-26 April 1168 A.D.
The Round Zodiac of Dendera:
morning of 20 March 1185 A.D.

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2. THE TWO ZODIACS FROM ESNA

The Egyptian town of Esna is located rather close to Dendera; this is the place where the Nile makes a great curve that spans a huge bight covered in hills

Fig. 13.7. Round Zodiac of Dendera (DR) with highlighted groups of symbols containing secondary astronomical data, which help us to make the dating more precise. Drawn copy from [1062], pages 9 and 71.

with many ancient Egyptian sepulchral caves carved into the rock. All the entrances were ingenuously concealed and walled-up. The city of Luxor (possibly a derivative of the Russian "*Luka Tsarei*", or the Royal Bight) is right across the Nile; it is supposed to be the same city as the ancient Thebes as described by Herodotus. One finds the ruins of two great Egyptian temples in and around Luxor – the Temple of Luxor and the Temple of Karnak.

Two temples with zodiacs on their ceilings were found in Esna. We shall refer to them as the Greater Temple and the Lesser Temple, since one of them is a lot bigger than the other. The zodiacs from the temples of Esna resemble the zodiacs of Dendera in the symbols they contain, although there are certain differences between them. See Chapter 17 of Chron3 for more information on the zodiacs of Esna and their astronomical imagery.

It is higly likely that all the ancient Egyptian constructions found in the "Royal Bight", such as the gi-

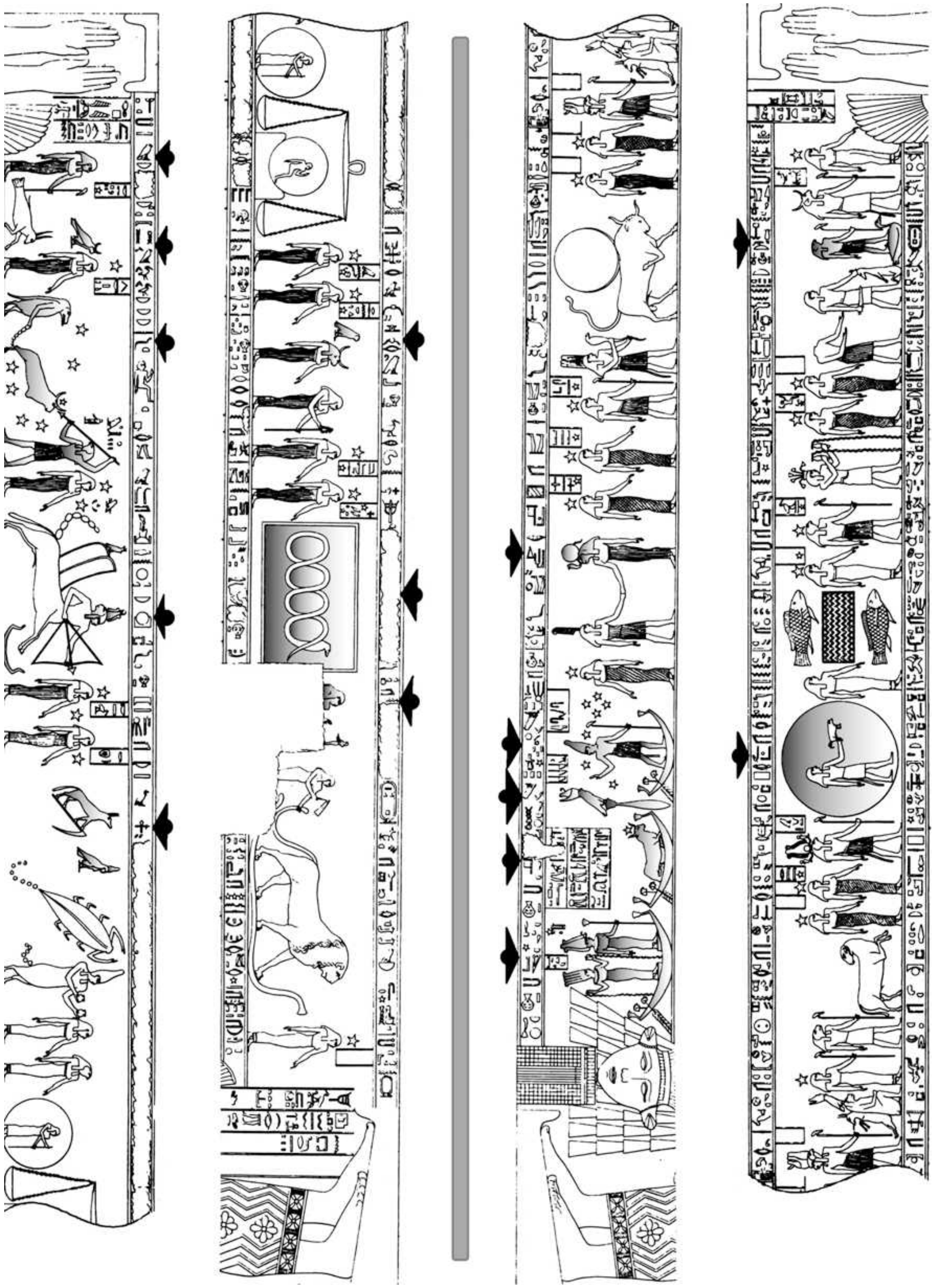

Fig. 13.8. Long Zodiac of Dendera (DL). Groups of symbols that contain additional astronomical information useful for making the dating more precise are shaded grey. Their locations are indicated by arrows. Based on the drawn copy from [1100], A. Vol. IV, Pl. 20.

gantic temples of Luxor, the sanctuary of Dendera, the Esna temples and so on, bear direct relation to the royal necropolis. In other words, all of them were built to be used for mortuary rites. It becomes clear why all the large stone zodiacs of the "ancient" Egypt (those from Dendera and Esna) were found at this site.

As we have already mentioned, Egyptian zodiacs are most likely to contain the birth or demise dates of the deceased. Ordinary representatives of the nobility would get zodiacs on the inside of their coffins. Great kings could have entire temples built to house their funeral zodiacs, which would be chiselled on the ceiling. Furthermore, some of the monumental funeral zodiacs from the ancient Egypt could bear some relation to Christ, his kin or the apostles. As we understand now, the "ancient" Egypt had been a Christian country, qv in CHRON5.

Copies of both zodiacs from Esna can be found in the Napoleonic album ([1100]), where one finds detailed shaded drawings of a considerable size, as well as drawn outlines of these zodiacs made by European artists during the Napoleonic military expedition to Egypt in the late XVIII – early XIX century.

As far as we know, the first attempt to interpret and date the Esna zodiacs astronomically was made in the work of T. N. Fomenko ([912:3]). We know of no other authors who wrote anything on this particular subject.

T. N. Fomenko appears to be the first to have suggested an interpretation of the Esna zodiacs. Her approach (as related above in brief) led her to the conclusion that both these zodiacs have a single solution (or dating) on the entire historical interval. The uniqueness of this solution was naturally tested according to the interpretation of the Esna zodiacs offered and documented in [912:3].

T. N. Fomenko's solution for the zodiacs of Esna is as follows:

The Long Zodiac of Esna:
1-2 May 1631 A.D.
The Round Zodiac of Esna:
2-3 May 1570 A.D.
(T. N. Fomenko, [912:3], pages 774 and 798.)

Our analysis of the zodiacs from Esna demonstrated that some of the symbols included by T. N. Fomenko in the primary horoscopes of the Esna zodiacs really pertain to the secondary horoscopes included in these zodiacs. It was discovered that the zodiacs of Esna, likewise the Dendera zodiacs, contain detailed horoscopes of a secondary nature. In other words, we have discovered a large volume of extra astronomical information in the Esna zodiacs; this information excludes the possibility of finding a random and extraneous solution on the entire historical interval, even considering that all possible zodiac interpretation options are accounted for in calculation.

See our detailed analysis and the results of dating the zodiacs of Esna by the method that we suggest below. We shall merely quote the solution here:

The Long Zodiac of Esna:
31 March – 3 April 1394 A.D.
The Round Zodiac of Esna:
6-8 May 1404 A.D.

This solution is unique for the entire historical interval between 500 B.C. and the present epoch.

3. FLINDERS PETRIE'S ATHRIBIS ZODIACS

The Athribis zodiacs of Flinders Petrie were studied by N. A. Morozov in [544], Volume 6, pages 728-752. They can be seen in fig. 13.9. N. A. Morozov describes these zodiacs, as well as the preceding attempts of dating them, in the following terms:

"In 1902 the British School of Egyptology in London published the oeuvre of W. M. Flinders Petrie entitled ***Athribis*** and containing the descriptions of the findings that this Egyptologist made in Upper Egypt (near Sohag) in 1901. Athribis, formerly known as Hat-Repit (or the Repit fortress), is located to the south of Dekr-Amba-Shenudeh (White Monastery), where the Egyptologists had previously found the remnants of a monastic cell that they dated to the IV century A.D. And to the south from it, near Hargazeh, where the surrounding rocks form many terraces descending into the Valley of the Nile, the researchers discovered artefacts that they dated to the Archaean period of the Egyptian kingdom.

Two other temples were found in Athribis itself – one of them was dated to the epoch of Ptolemy IX,

Fig. 13.9. The Athribis zodiacs of Flinders Petrie (AV and AN). Drawn copy published by Flinders Petrie (see [1340:1], for instance) and reproduced by N. A. Morozov in [544]. Taken from [544], Volume 6, page 730.

Fig. 13.10. The Athribis zodiacs of Flinders Petrie (AV and AN). A fragment of the drawn copy. The man with his arm in the air and the birds are shaded grey and symbolise the planets that were close to the Sun on solstice day. Taken from [544], Volume 6, page 730; see also [1340:1].

and the other was said to have been 'started by Ptolemy XIII Auletes (Court Theomachist) and finished by Claudius and Hadrian'. The town itself is located at the very edge of the desert, and so this ancient relic was covered in sand, which is a very rare case, since Egyptian sepulchres are usually buried in mud from the Nile that is a great deal more detrimental to their condition.

The last of the two temples mentioned above belonged to the same type as the Dendera temple (or the Edfu temple); however, the surrounding colonnade reveals a Greek influence, and the sculptural decorations of both pertain to the "Roman culture".

The material used for their construction is limestone from the local middle quarries which becomes easily eroded due to atmospheric conditions; as a result, many local constructions are built from sandstone.

At a small distance from the excavation sites of these temples on the lower terraces of the plateau that descends into the Nile Valley which are anything but easily accessible, even when the sand is removed, Flinders Petrie discovered an artificial sepulchral cave whose walls were covered in artwork and inscriptions, with two horoscopes on the ceiling, drawn and painted in a multitude of colours; they formed a single composition and were most likely drawn by the same artist; that is to say, the upper horoscope predates the lower by thirty years maximum, and most probably, by a lot less than that. [N. A. Morozov's presumption about the maximal interval between the two zodiacs equalling thirty years maximum had proved erroneous, and greatly hindered his astronomical dating – Auth.]. The zodiacal figures are Hellenistic in character; however, they also demonstrate several purely Egyptian distinctive traits. Thus, the constellation of Orion below, for instance (in the lower part of the drawing) looks like a man with his right hand raised, inviting the souls of Meri-Hor and his father Ab-Ne-Mani, as they are referred to in the hieroglyphic inscriptions nearby, to ascend into heavens; they are accompanied by their earthly sins presented as snakes and jackals (on the left of the picture). Both souls look like birds with human heads; the upper horoscope must have been drawn for the father, and the lower for the son. However, both horoscopes apparently refer to the dates of their ascension

and not their birth, which is the only case for which it would be apropos to portray them as birds here" ([544], Volume 6, page 731).

Let us interrupt Morozov's narration for a while. We have just come across the vary point in his reasoning that greatly complicated his interpretation of Egyptian zodiacs. Namely, when faced with the symbols that he deemed to bear no relation to the horoscope of the zodiac in question, Morozov would have no qualms about declaring them to be of a religious or mystical nature, and with zero relevance to astronomy. In this case, for instance, he misinterpreted important astronomical information from the Athribis zodiacs as religious symbolism – namely, the signs of the secondary summer solstice zodiac, qv in fig. 13.10. We shall cover secondary horoscopes found upon Egyptian zodiacs in detail in CHRON3, Chapter 15.

The Dating of the Horoscopes

Be E. B. Knobel.

Second Horoscope,

	Geocentric Longitude.	Epoch, A. D. 52.
Sun in Taurus	31° — 60°	May
Moon in Gemini	61° — 90°	May 20 (New Moon, May 17)
Mercury in forepart of Taurus.	31° — 45°	?
Venus in hindpart of Taurus.	45° — 60°	25° Longitude greater than Sun
Mars in Cancer	91° — 120°	92°
Jupiter between Capricornus and Aquarius	300°	306°
Saturn in Pisces	331° — 360°	358°

The year A. D. 52, May 20, suits well for Moon, Venus, Mars, Jupiter and Saturne:

First Horoscope,

	Geocentric Longitude.	Epoch. A. D. 59.
Sun between Capricornus and Aquarius	300°	January 20
Moon in Sagittarius	241° — 270°	About Last Quarter, January 25
Mercury in forepart of Capricornus	271° — 285°	?
Venus in Pisces	331° — 360°	250°
Mars in Aquarius	301° — 330°	327°
Jupiter in Leo	121° — 150°	148°
Saturn in Gemini	61° — 90°	58°

Fig. 13.11. The Athribis zodiacs of Flinders Petrie (AV and AN). Knobel's solution. According to Knobel himself, the solution in question is neither good, nor even a complete solution at all. For instance, the position of Mercury wasn't calculated anywhere. The corresponding lines contain question marks. Taken from [544], Volume 6, page 732, as copied from Knobel's work.

The planetary figures of birds from the secondary horoscope were declared to represent "the souls of the deceased father and son" erroneously, despite the fact that Morozov himself made the perfectly justified assertions that the birds found on the zodiacs of Athribis stand for planets.

In this particular case, N. A. Morozov's error stemming from his having confused the secondary horoscope for a mystical scene proved to be serious. Firstly, he had lost important astronomical information bearing direct relation to the dating. Secondly, Morozov's erroneous interpretation of the Egyptian symbols confirmed his false presumption that the maximal interval between the two Athribis datings should equal 30 years. In reality, this interval equals 38 years as we shall see below in Chapter 18 of CHRON3. At the same time, Morozov's assumption that the Athribis zodiacs stand for the demise dates of the father and son buried in this cave appears to be correct.

Let us carry on with quoting from N. A. Morozov:

"The dating of this sepulchre, likewise that of the abovementioned Dendera zodiacs, is all the more reliable due to there being two horoscopes separated by a short time interval in both cases.

Upon having received the fourth volume of the ***British School of Egyptology*** that contained these zodiacs from Professor Turayev in the summer of 1919 in order to date them with more precision astronomically, the first thing I did was to repeat Knobel's calculations as cited in the book. Likewise other Egyptologists, he identifies the bird with the serpent's tail as Jupiter casting serpent-like lightning bolts, the bird with a bovine head as Saturn, the falcon located at some distance from the Sun as Mars, and the two-headed Janus together with the bird bearing no special indications in the vicinity of the Sun as Mercury and Venus. My control calculations demonstrated Jupiter to lay a lot further to the left in both horoscopes, likewise Mars, whereas Saturn is further to the right than it should be in the lower horoscope. The result was even worse than Knobel's" ([544], Volume 6, page 731).

It has to be said that Knobel himself was far from satisfied with his astronomical dating of the Athribis zodiacs to 52 and 59 A.D. In fig. 13.11 we cite Knobel's calculation table as reproduced by N. A. Morozov in [544], Volume 6. The very first glance that we cast on this table demonstrates that in this case Knobel was far from attempting to find an independent astro-

nomical dating of the old zodiac, and merely tried to come up with the "most fitting" dating from the astronomical point of view that would be located in the a priori known dating interval as specified by the Egyptologists for the zodiac in question. It is clear that one can always find the most fitting date in a given interval. Whether or not it should really be satisfactory is an altogether different issue. Knobel's dating proved horrendously bad.

The concurrence between the Athribis zodiacs and the calculated celestial sphere of Knobel is so bad that it can be achieved for any epoch at all. Knobel himself

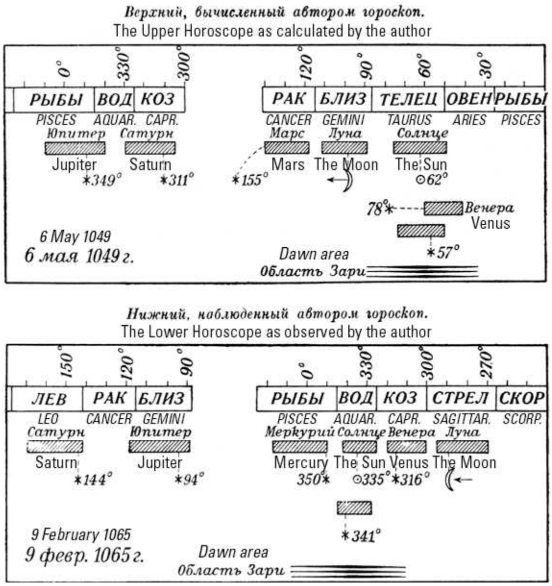

Fig. 13.12. The dating of Athribis zodiacs discovered by Flinders Petrie (AV and AN). The drawing is taken from the book of N. A. Morozov ([544], Volume 6, page 747), where it is accompanied by the following note: "All the planetary positions where the asterisks (planets) are located below the respective strip. In the lower horoscope everything is perfectly correct, since it is the only one that was really observed by the author. As for the upper … Mars and Venus are shifted leftwards as compared to the positions they should occupy" ([544], Volume 6, page 747). Thus, N. A. Morozov concedes that the solution that he came up with for the Lower Zodiac is imprecise. Morozov tries to explain this lack of precision by the fact that the Lower Zodiac was compiled by the author from observations and not calculated, unlike the Upper Zodiac. However, we shall witness this presumption to be of a superfluous character, since there a precise solution of the Athribis zodiacs does in fact exist.

made the following perplexed comment in this respect:

"The horoscope positions are probably taken from tables and not from observations, and the positions are in signs and not in constellations. The year A.D. 59, January, suits well for Moon, Mars, Jupiter and Saturn, but is discordant for Venus. No attempt has been made to reconcile Mercury. Jupiter and Saturn would be in similar relative positions about every 58 or 59 years. In the epochs –118, –60, –1, 59, 117, the only year that suits the tree superior planets is A.D. 59, but the position of Venus is quite wrong for that year" ([544], Volume 6, page 732.)

Let us return to the interrupted narration of Morozov. He writes further that "in order to decide which one of us had been right and in order to check for a better solution, I ordered the late M. A. Vilyev, who had been my assistant at the Department of Astronomy in the Lesgaft Institute of Science at the time, to run a special investigation for this artefact [the zodiacs of Athribis – Auth.].

He performed exhaustive calculations for these zodiacs for the interval between 500 B.C. and 600 A.D. … it turned out that Viliev also failed to come up with any satisfactory results, as one can see from his own conclusions" ([544], Volume 6, pages 731-733).

Having discovered no satisfactory solution, N. A. Morozov was forced to revise his interpretation of the Athribis zodiacs and introduce certain corrections into it – namely, to make Jupiter and Saturn swap their respective positions, qv in [544], Volume 6, pages 738-739). The new interpretation yielded 1049 A.D. as the solution for the Upper Zodiac and 1065 A.D. for the Lower, qv in fig. 13.12, which is an actual drawing by Morozov that demonstrates his solution to be far from ideal. Furthermore, he had to assume that only the Lower Zodiac had been compiled from actual observations, whereas the Upper was calculated, and imprecisely so. Otherwise there could be no explanation why Mars fails to occupy its rightful place on the Upper Zodiac, qv in fig. 13.12.

Apart from that, the order of planets in Morozov's solution differs from their order on the Athribis zodiacs. The order of planets on the Lower Zodiac in Morozov's interpretation, for instance, is as follows: Mercury, Venus, the Sun and Mars (from right to left, qv in fig. 13.9). It is completely different from Moro-

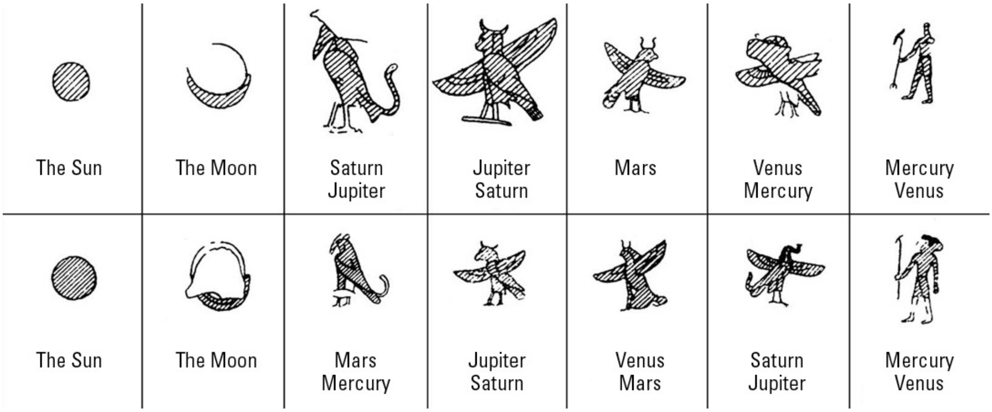

Fig. 13.13. The Athribis Zodiacs of Flinders Petrie (AV and AN). We see planets drawn as birds. The top row corresponds to the Upper Zodiac's planets, and the bottom row – to those from the Lower Zodiac. The top lines of inscriptions represent Morozov's identifications, and the bottom lines – the identifications made by Nobel (in cases where the two differ from each other). Similar planetary birds are drawn one over the other.

zov's solution – Mercury, Mars, the Sun and Venus (see fig. 13.12). Therefore, Morozov's claim that "everything is doubtlessly correct" in his solution for the Lower Zodiac is obviously an exaggeration ([544], Volume 6, page 746). In reality, Morozov's solution contains a number of distortions, the most substantial of which shall be discussed below.

N. A. Morozov wrote the following in re his new interpretation of the Athribis zodiacs: "The first issue that arose had been of just how correctly the British School of Egyptology identified the bird with a serpent's tail as Jupiter, and the bird with the bovine head as Saturn. The actual book of Flinders Petrie contains no indications concerning the legitimacy of this choice" ([544], Volume 6, page 738). Morozov proceeds to suggest swapping the respective positions of Jupiter and Saturn: "It is known that Jupiter turned into a bull, which had never been the case with Saturn. Saturn was considered an evil-boding planet … it would therefore make sense to draw it with a serpent's tail, unlike Jupiter, a benevolent planet. Of course, one could also consider these snakes to represent lightning bolts à la Flinders Petrie" ([544], Volume 6, page 739).

N. A. Morozov's reasoning can hardly be considered finite. Let us point out that he had to resort to it once he discovered there were no solutions for the initial interpretation that he didn't object to initially. As for identifying the bird with a bovine head as Saturn, as the Egyptologists suggest, it can also be validated to a sufficient extent, which wouldn't be any less viable than Morozov's validation of his new interpretation. As a matter of fact, the figure of Saturn is always accompanied by the symbol of an ox in the zodiacs of Dendera, qv in CHRON3, Chapter 15.

Therefore, the issue of identifying Jupiter and Saturn on the Athribis zodiacs remains poignant, especially considering how N. A. Morozov failed to have found a fitting solution.

However, it doesn't end here. Our analysis of the previous interpretations of the Athribis zodiacs – Morozov's as well as the one offered by the Egyptologists, demonstrates both to contain a grave inconsistency – namely, the fact that the same birds on both zodiacs are for some reason identified as different planets. In fig. 13.13 we cite the full set of planetary symbols as used in both zodiacs together with their identifications according to Morozov and the Egyptologists. The drawing demonstrates that none of these identifications satisfy to the simplest and most natural condition that the same planetary figure as used on both zodiacs has to refer to the same planet. It is clear that once we neglect this condition, we get plenty of opportunities to identify the planets in every which way, and arbitrarily at that, getting perfectly invalid datings as a result.

Let us explain the contents of fig. 13.13. In the upper row we see the planetary symbols used in the Upper Zodiac of Athribis, and in the lower – the respective symbols from the Lower Zodiacs. The actual zodiacs can be seen in fig. 13.9 above. All the planets are presented as birds, except for Mercury, which looks the same as on the Dendera zodiacs – a two-faced man carrying a rod. The upper row of text represents N. A. Morozov's identifications, and the lower – Knobel's, where they differ from the above ([544], Volume 6, page 732).

The bird-planets from both zodiacs that correspond to each other are drawn one above the other in fig. 13.13; one can clearly see that there are two horned birds on each zodiac (see figs. 13.9 and 13.13). It is significant that their horns are shaped differently – as a crescent in one case, and with curved ends in the other. The horn shape makes the birds correspond to one another perfectly; in general, in fig. 13.13 one sees that the birds, or planets, from both zodiacs represent the same set of figures. This is exactly how it should be, since the symbols used for the two zodiacs of Athribis that comprise a single composition should be the same, qv in fig. 13.13.

However, the least implication of the above is that similar birds stand for similar planets in both zodiacs. It turns out that neither Knobel, nor Morozov managed to accomplish this in their identifications, which should mean that their interpretation contained errors of some sort. Let us point out that Knobel (possibly, following Brugsch) makes a blatant mistake in his identification of Venus, a perfectly "female" planet, as the male two-faced figure, as we already mentioned above.

We shall refrain from analyzing the reasons why Morozov's interpretation of the Athribis zodiacs should contain errors; they might be linked to his erroneous opinion that the interval between the datings ciphered in the two zodiacs should not exceed 30 years ([544], Volume 6, page 720).

In our analysis of the Athribis zodiacs we have tried every single option of identifying the "Athribis birds" as planets uniformly. Apart from that, we have used additional astronomical information from the secondary summer solstice horoscope contained in the lower zodiac. See more on our solution for the Athribis zodiacs in CHRON3, Chapter 18. We shall just quote our end result here, which happens to be unique for the entire historical interval between 500 B.C. and the present. Our solution is as follows:

The Upper Zodiac of Athribis:
15-16 May 1230 A.D.
The Lower Zodiac of Athribis:
9-10 February 1268 A.D.

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4. THE THEBAN ZODIAC OF BRUGSCH

The Theban Zodiac of Brugsh was described and studied by Morozov in detail in [544], Volume 6, pages 695-728. A drawn copy of this zodiac made by Brugsch himself can be seen above in fig. 13.17. A close-in with the fragment containing the horoscope under study is presented in fig. 13.14. The names of the planets are written explicitly between the constellation figures, therefore, the interpretation of this horoscope presents no particular problems. N. A. Morozov had studied the issue of the horoscope's dating with the utmost care. The account of his experience with Brugsch's zodiac begins as follows:

"One day in 1913, N. V. Roumyantsev who had still been a student in the Institute of Philology and known that I was involved in the dating of the ancient horoscopes, brought me a book by Heinrich Brugsch from his institute's library (Henri Brugsch: ***Recueil des Monuments Egyptiens, dessinés sur lieux***. 1862), which, among other things, contained the description of a perfectly conserved coffin made of sycamore wood (which had looked relatively recent), with beautiful decorative artwork, which is in Monier's collection presently. Brugsch reports to have made the discovery in 1857; however, the description was published as late as 1862.

The coffin contained a mummy that looked just like the regular Egyptian mummies … the most interesting thing for either a historian or an archaeologist who would want to know the exact dating of this coffin could be found on the inside of its lid. The female figure of Nuit was drawn in its middle in such a way that it looked as if it were covering the mummy … with the 12 zodiacal constellations to the left and to the right looking exactly the same way as in the as-

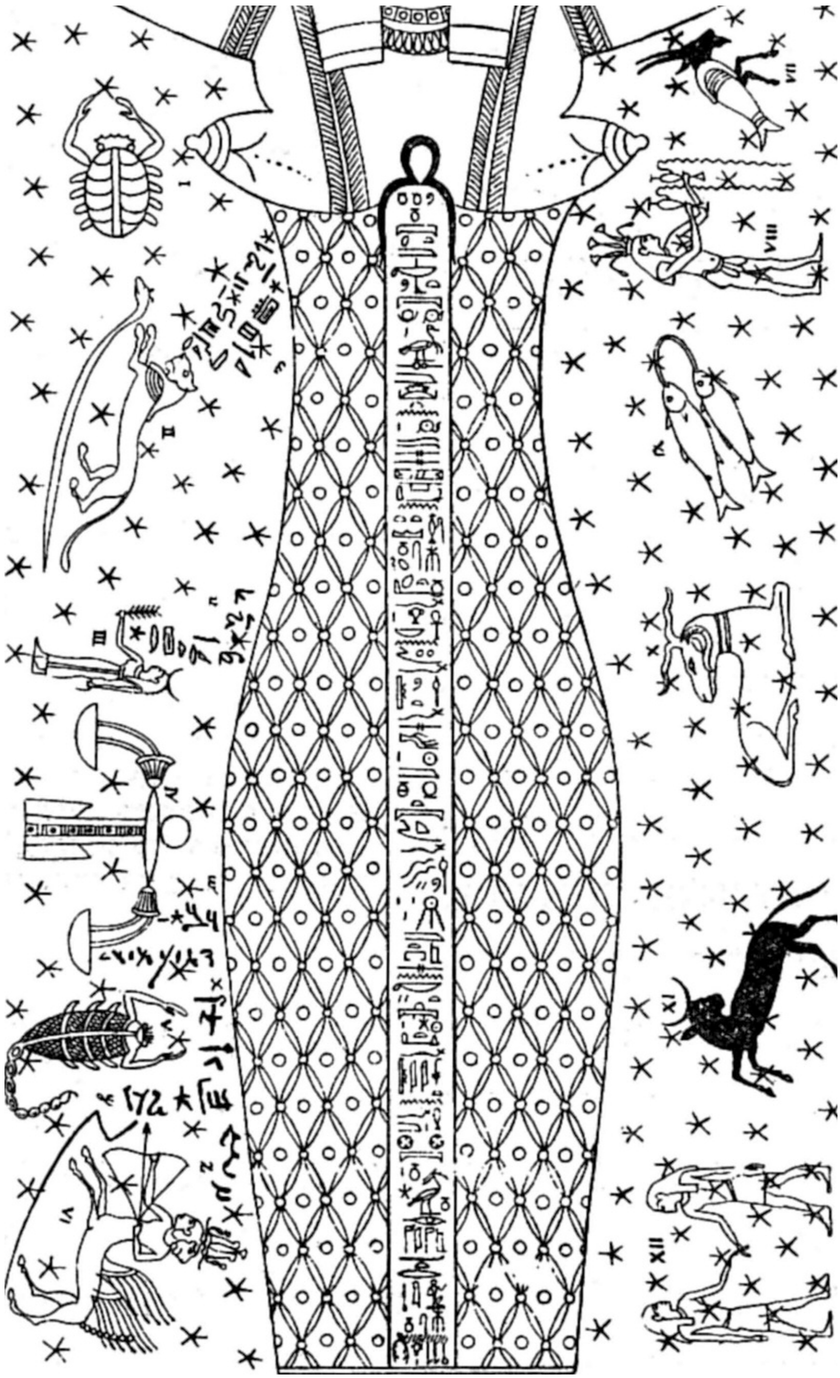

Fig. 13.14. Brugsch's Theban Zodiac (BR). Fragment of the drawn copy published by H. Brugsch. Near the constellation figures of Leo, Virgo, Libra, Scorpio and Sagittarius one can plainly see the row of demotic subscripts with planetary names comprising a horoscope. This horoscope was discovered by H. Brugsch and then dated by N. A. Morozov. The possible dating for this horoscope is either 1861 (ideal astronomical solution) or 1692 (solution chosen by Morozov). Taken from [544], Volume 6, page 696.

tronomical oeuvres from the epoch of the Enlightenment. An even more remarkable thing can be seen on the outline of the lid, namely, 24 identical human figures before altars. They clearly stand for 12 diurnal hours and 12 nocturnal hours; both bear indications in Arabic numerals done by Brugsch himself and should not confuse the readers, likewise the other (literal) indications that one sees in our drawing" ([544], Volume 6, pages 694-695).

This drawing of Brugsch is reproduced by Morozov in [544], Volume 6, page 696 (see fig. 13.17 and 13.14). Let us carry on with quoting from N. A. Morozov:

"We see four mythological creatures on four angles of the coffin lid, apparently having the same meaning as they do in the Apocalypse: Taurus, Leo, Centaurus and Aquila. On the right there are human figures in boats which appear to be crossing the Acheron, and also an ibis and something resembling a dais; to the right we see a scene of a sacrifice. The hieroglyphs scattered across the lid do not contain any historical indications of any kind and name the deceased "Osirien".

The figure of Scorpio among the twelve zodiacal constellations is shaded, which signifies its invisibility in the rays of the Sun, which happens in November; the figure of Taurus that opposes it is blackened, which symbolizes its nocturnal reign, or the fact that it culminates during the night. The Moon can be seen over the head of Virgo as a crescent, which is how it looks with the Sun in Scorpio, and the circle over Libra that I initially deemed to represent the Sun in Libra (ignoring the shaded Scorpio and the blackened Taurus) simply symbolizes the fact that the autumn equinox that the civil year begins with was counted from the moment when the Sun left Virgo and moved into Libra, according to the Byzantine Christian tradition [Morozov is referring to the ecclesiastical beginning of the year in September – Auth.] … This very symbol of Libra with the solar circle on the balance-beam is frequently encountered in ancient astronomical zodiacs, and therefore cannot serve as a horoscope indication …" ([544], Volume 6, page 697).

Let us interrupt N. A. Morozov for a second. He was wrong to have written off the circle in Libra quite as easily. Our analysis of the Egyptian zodiacs demonstrates that this circle usually stands for the Passover full moon and is directly relevant to astronomical dating. We shall relate the issue in more detail since it is crucial for understanding the symbols used in Egyptian zodiacs.

The Passover full moon is the name used for the first full moon to follow the spring equinox. It takes place in March or in April, within a month counting from the day of the spring equinox. This is the time when the Sun passes the constellation of Pisces and moves into Aries. However, two thousand years ago the Sun would pass the constellation of Aries after the spring equinox and then move into Gemini, qv in fig. 13.15. Therefore, over the last two thousand years the first vernal full moon would often be located in Libra, since it is the constellation directly opposing Aries. Let us explain that a full moon is always located on the opposite side of the ecliptic from the Sun. Therefore, if the Sun is in Aries during full moon, the Moon can be seen in Libra.

This is exactly the reason why the circle in Libra that Morozov refers to can often be seen in Egyptian zodiacs. However, it stands for the Passover full moon and not the Sun, as he had thought. We shall consider this issue below and provide the necessary examples.

This error made by N. A. Morozov in his interpretation of the astronomical meaning of the circle in Libra isn't too grave in the present case since it provoked no errors in astronomical dating due to the fact that it does not pertain to the primary horoscope on the zodiac of Brugsch, which is the case with many other Egyptian zodiacs. Nevertheless, such errors can be detrimental to the actual understanding of the Egyptian astronomical symbols as used in zodiacs, which would in turn lead to serious errors in their interpretation and astronomical dating.

Let us now return to N. A. Morozov's narration in re the zodiac of Brugsch. We must point out that Morozov only managed to find a single horoscope in this zodiac, namely, the one transcribed in demotic symbols, qv in figs. 13.17 and 13.14. One sees planetary names near the constellation figures. However, our analysis of Brugsch's zodiac demonstrates that it contains two more horoscopes, which were overlooked by N. A. Morozov. Unlike the "demotic" horoscope, they are part of the actual zodiac and not mere subscripts. It is odd that neither Brugsch, nor Morozov happened to notice it.

Среднее соответствие юлианских месяцев и созвездий Зодиака за последние $2^1/_2$ тысячи лет.

I Янв. — Солнце в Козероге	VII Июль — Солнце в Раке
II Февр. — Солнце в Водолее	VIII Август — Солнце в Льве
III Март — Солнце в Рыбах	IX Сент. — Солнце в Деве
IV Апрель — Солнце в Овне	X Октябрь — Солнце в Весах
V Май — Солнце в Тельце	XI Нбр. — Солнце в Скорпионе
VI Июнь — Солнце в Близнецах	XII Дек. — Солнце в Стрельце

Average correspondence between the Julian months and the Zodiacal constellations for the last 2.5 thousand years

I January – Sun in Capricorn.	VII July – Sun in Cancer.
II February – Sun in Aquarius.	VIII August – Sun in Leo.
III March – Sun in Pisces.	IX September – Sun in Virgo.
IV April – Sun in Aries.	X October – Sun in Libra.
V May – Sun in Taurus.	XI November – Sun in Scorpio.
VI June – Sun in Gemini.	XII December – Sun in Sagittarius.

Fig. 13.15. Average correspondence between the Julian months (old style) and the position of the Sun on the Zodiac as observed from the Earth for the last 2500 years. The table was compiled by N. A. Morozov. Taken from [544], Volume 6, page 711.

Morozov proceeds to tell us that "the documental and therefore important symbols here are just the ones rendered in demotic writing and less even lines on the left hand side … The coffin was apparently crafted by some professional according to specimens used at the time, whereas the demotic inscriptions must have been made by a professional astrologer specializing in horoscopes, whose subscripts must therefore be taken very seriously indeed.

The most remarkable lines are the two found between Cancer and Leo, directed towards Leo's head. One of them says Hor-pe-Setah and the other – Hor-pe-Ka, referring to the respective planets Saturn and Jupiter; the very proximity of the lines to one another, given the amount of free space available, demonstrates that Jupiter and Saturn had been in close conjunction, that is, Jupiter took over Saturn with the Sun in Scorpio. The date must therefore pertain to the end of the Julian month of October or November, somewhere along the historical interval. Near Virgo, closer to Leo, we encounter the legend Hor-Teser in demotic writing, standing for the planet Mars. Between Scorpio and Sagittarius (curving towards the head of the latter) we find the demotic subscript saying Pe-Nether-Tau, or the Morning Luminary, alias Venus – despite the fact that Venus could only be seen in this position in the evening, which testifies to the fact that the astrologers of that epoch knew the morning and the evening Venus to be the same planet. Finally, there is a line saying Sebek, or Mercury, between Scorpio and Libra; however, we cannot trust the precision of its topography, since there is no more space for Mercury left to the right of Scorpio, and, apart from that, it isn't visible at such a close distance from the Sun. Therefore, the author of the horoscope was guided by certain ulterior considerations of his own, and not actual observations.

Demotic writing had first been deciphered by Akerblad in 1802, 20 years before Champollion had deciphered the hieroglyphic script. It is considered to be more recent than the hieroglyphs … Brugsch dated his finding to the time of the "Roman rule in Egypt", which couldn't possibly postdate the first century A.D.

It goes without saying that I put my best effort into estimating the time when this most remarkable document was created … but the solution I ended up with – the single date of the 17 November 1682 A.D., was so amazing that I could hardly believe my eyes … I can admit that a solution such as this one would render any modern Egyptologist unconscious, and I confess to having fallen unconscious myself" ([544], Volume 6, pages 697-698 and 727).

However, Morozov proceeds to admit candidly that his solution of 1682 is far from being the only one. It turns out that there is another fine solution whose date we shall cite below, one that is even better than the first, the only difference being that the conjunction of Jupiter and Saturn takes place near the tail of Leo and not the head. However, it is easy to see that the zodiac of Brugsch allows for their conjunction in any part of Leo and not just the head (see fig. 13.14). The fact that the lines with the names of Jupiter and Saturn wound up near the head and not some other part of Leo tells us nothing, since these lines must have approached Leo at some point. The person who wrote the planetary names on Brugsch's zodiac wasn't too likely to estimate their precise position within a constellation. In general, Egyptian zodiacs don't allow for such precision, and the zodiac of Brugsch is no exception (see fig. 13.14).

It is therefore most doubtful that the author of Brugsch's zodiac would try to attain this degree of precision. It is unlikely that even the reference zodiac that he got from astronomers and followed in his work would contain exact positions of planets in constellations.

At any rate, we aren't entitled to making such assumptions without having substantial grounds for doing so. And our analysis of the Egyptian zodiacs demonstrates that their authors never attempted to specify the positions of planets inside constellations with precision, even in those cases when the amount of detail in a zodiac and the size thereof could allow it. This was never the case, as Morozov himself points out.

For instance, the Long Zodiac of Dendera has two additional figures for each constellation, each representing the ten-grade mark; we therefore have three figures instead of one for each constellation, qv in Chron3, Chapter 15:2.1, as well as the analysis of the Dendera zodiacs in Morozov's book ([544], Volume 6, pages 675-688). These ten-grade marks allow to specify planetary position with the precision of 1/3 constellation as marked by those figures; thus, the author of the zodiac could have used the middle ten-grade figure in order to specify the position of a given planet in the middle third of the constellation in question etc. However, Egyptian artists did none such thing, although it appears that they could have easily used this excellent opportunity to make the planetary positions on their zodiacs more precise.

The planets in the Long Zodiac are distributed across these ten-degree marks chaotically, which was mentioned by N. A. Morozov ([544], Volume 6, page 688). This was confirmed by our analysis, qv below. Therefore, making the planetary positions more precise appears to have been beyond the interests of the authors of the Egyptian zodiacs. It is therefore dangerous to refer to considerations concerning precise planetary locations inside constellations for the dating of Egyptian zodiacs.

Therefore, Morozov's second solution for Jupiter and Saturn also turns out to be strict. It might be somewhat worse than the first, but this "somewhat" is already beyond the principal precision limit of the Egyptian zodiacs. However, in the second solution the planetary order ideally corresponds to that indicated on the zodiac ([544], Volume 6, page 726), while in the first 1682 solution Mercury wound up between Scorpio and Sagittarius, whereas its name is written between Scorpio and Libra, qv in fig. 13.16. The problem here is that the planetary order is changed, placing Mercury on the opposite side of the Sun as compared to its zodiacal position.

However, the change of planetary order is absolutely unacceptable for solving the Egyptian zodiacs. Below we shall witness that the planetary order on the ecliptic would always be adhered to rigidly in those, although Morozov hadn't been aware of this important circumstance, which was first pointed out by T. N. Fomenko in [912:3].

Let us explain why the swapped places of Mercury (planet) and Scorpio (constellation) affect the order of planets as well. The matter is that the Sun is in Scorpio, and it ranked among the seven planets known to ancient astronomy and was also considered a planet, as we already mentioned. The sign of Scorpio on Brugsch's zodiac is shaded to signify that it contained the Sun – which "blazed" in the rays of sunshine, qv in fig. 13.14. N. A. Morozov had noticed this, and was perfectly correct to have interpreted it as an indication of the Sun being in Scorpio. Thus, Mercury and Scorpio with their positions swapped result in the swapping of positions between Mercury and the Sun, or a planetary shift.

This makes the 1682 solution less strict. Morozov had been aware of this and tried to provide explanations, which we cannot consider substantial enough. The poor placing of Mercury in the 1682 solution, for instance, was explained in the following manner: "the name of Mercury couldn't be crammed into its proper position, and so it became misplaced" ([544], Volume 6, page 727). This is a possible explanation, yet it does not eliminate the inconsistency.

As for the second solution – its shortcomings are as follows, according to N. A. Morozov. Firstly, as we already mentioned, he disliked the fact that Jupiter and Saturn ended up near the tail of Leo, whereas on the zodiac their names are closer to Leo's head. Secondly, Mars in Virgo is closer to Libra than to Leo in this solution, contrary to Morozov's aspiration.

However, Brugsch's drawing of the Zodiac once again doesn't allow us to estimate the position of Mars in Virgo with more precision, qv in fig. 13.14. The inscription containing the name of Mars is directed ver-

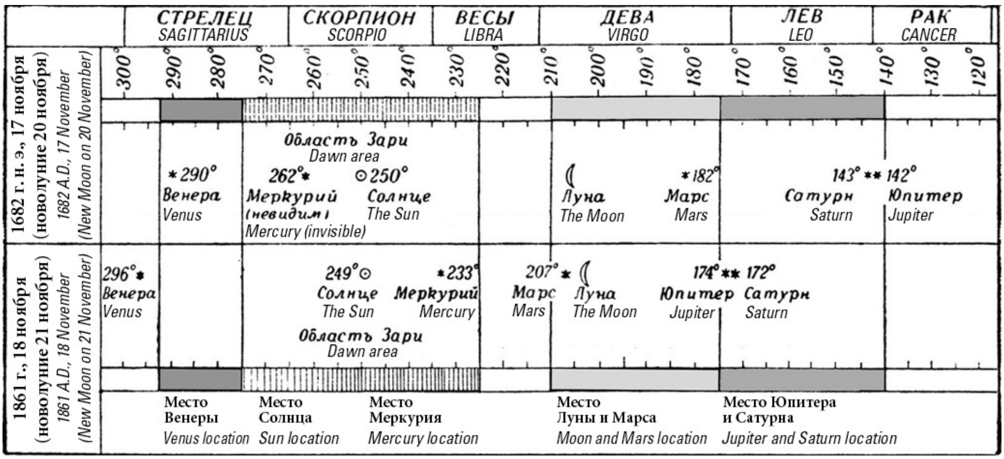

Fig. 13.16. Brugsch's Theban Zodiac (BR). The two solutions of the "demotic" horoscope from Brugsch's zodiac that were discovered by N. A. Morozov – 17 November 1682 and 18 November 1861. Morozov had rejected the second solution, which predates Brugsch's publication of the zodiac by a mere year, as an absurd one. However, as we shall see below, it is this very solution that corresponds to reality. The solution of 1682 is imprecise insofar as Mercury is concerned – we see that the planet is on the wrong side of the Sun in comparison with the zodiac. Moreover, Mercury was invisible in this position. All the planets in the 1861 solution are located in the constellations indicated in the zodiac, meeting the order stipulations as well; all of them were visible. The drawing is made according to the one cited by Morozov in [544], Volume 6, page 726.

tically upwards as seen from the figure of Libra, making a slight curve towards Leo in the end, directed away from the figure of Nuit. Nevertheless, this inscription is closer to Leo than to Libra, qv in fig. 13.14. One can hardly obtain any substantial data concerning the position of Mars in Virgo from this drawing. The only obvious thing is the actual location of Mars in Virgo – nothing apart from that. This renders the "shortcoming" mentioned by Morozov null.

Thus, although N. A. Morozov had tried to prove that his second solution is a great deal worse than the first one (dating to 1682, qv in [544], Volume 6, page 726), a closer study reveals the fact that both defects that he brings to our attention happen to be beyond the precision threshold of the Egyptian drawing, and are thus completely uninformative. The important thing is that the planetary order and the constellation are specified correctly.

It is peculiar that N. A. Morozov had confused the respective order of Mars and the Moon on his drawing for the second solution, which would make the second solution look somewhat worse – however, the order of Mars and the Moon in relation to each other is of no relevance, since the Moon, which moves very fast, would have occupied both locations to the left and to the right of Mars by definition.

Let us now cite the dating of the second, *ideal* solution of the "demotic" horoscope. It is 1861 A.D., which predates 1862, the year of Brugsch's publication, by a single year. The dating falls on the second part of the XIX century, no less!

It is now obvious why N. A. Morozov would reject this solution as absurd. He even made the following ironic commentary in re the possibility of dating this zodiac to 1861: "first and foremost, we shall have to admit that Brugsch himself had created this zodiac, thus dating his description of this sepulchre to 1861 when everything was exactly as it is stated in the horoscope, save for the fact that the close conjunction of Jupiter and Saturn took place near the tail of Leo and not the head" ([544], Volume 6, page 728).

Indeed, in such circumstances we would most probably also have chosen the 1682 solution, although it is worse from the astronomical point of view. However, further analysis of Brugsch's zodiac reveals many other interesting details.

The matter is that we have discovered two more full primary horoscopes in Brugsch's zodiac, and ones

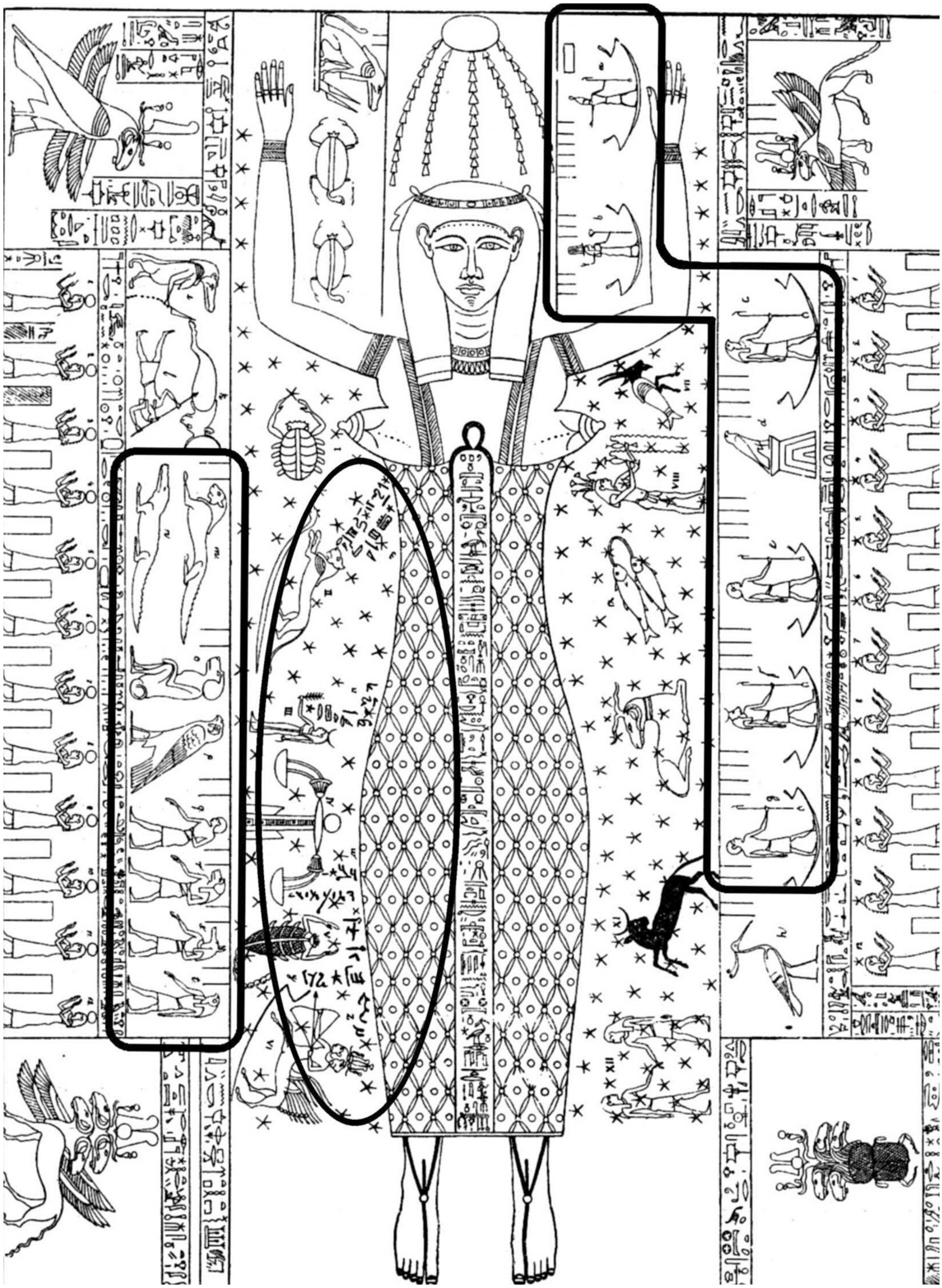

Fig. 13.17. Brugsch's Theban Zodiac (BR). The demotic subscript horoscope is highlighted by an oval. Apart from that, we highlighted the two other horoscopes that we discovered – the ones that weren't found by either Brugsch or Morozov. These horoscopes are an integral part of the entire artwork, and yield a single pair of close datings – 6-7 October 1841 and 15 February 1853. They are likely to be the dates of birth and death of the person buried here – a boy or a girl of 12. Several years later, the coffin with the mummy was sold to European collectors and came into Brugsch's possession. Somebody had used demotic writing to add a 1861 horoscope to the zodiac – as a joke or a mockery. Taken from [544], Volume 6, page 696.

that serve as an integral part of the zodiac itself. The "demotic" horoscope clearly dates to a later epoch, which wasn't left unnoticed by Morozov, qv above.

One of the new horoscopes that we discovered in Brugsch's zodiac is located on the left – the same side as the demotic subscripts, but closer to the edge of the zodiac. The second horoscope is on its opposite, qv in fig. 13.17. All the planetary figures of the second horoscope stand in boats, so we shall simply refer to it as to "the boat horoscope". All the planetary figures of the first horoscopes were drawn without rods, possibly in order to avoid confusion with the boat horoscope. We shall therefore be referring to the first horoscope as to the "horoscope without rods".

In fig. 13.17 we see a drawn copy of Brugsch's zodiac with 3 horoscopes pointed out explicitly – the "demotic" horoscope dated by N. A. Morozov as well as the two "original" ones that escaped the attention of both Morozov and Brugsch. See more details concerning the dating of all three horoscopes from Brugsch's drawing below, in CHRON3, Chapter 18. We shall simply cite the end result herein.

Both the "boat horoscope" and the "horoscope without rods" from Brugsch's zodiac only have a single pair of solutions close to each other, namely, 6-7 October 1841 for one of them and 15 February 1853 for the other.

The two horoscopes on the coffin lid may have referred to the dates of birth and death of whoever was buried there – apparently, a boy or a girl of 12 years.

However, this implies that the "demotic" horoscope refers to a XIX century date and not a XVII century one, since it was added somewhat later. It turns out Morozov's second solution, the one he rejected on the grounds of its being "too recent", is in fact the correct one, whereas the first solution of 1682 is too early. One gets the impression that what was presented to Brugsch as an "ancient" sepulchre had been a freshly-made coffin that couldn't have been older than a mere couple of years. N. A. Morozov had every right to be surprised about the fact that this coffin looked just like new ([544], Volume 6, page 695).

One could assume that in the XIX century Egypt the old Mameluke burial traditions were still observed in some of the families. Bear in mind that the Mamelukes in Egypt had been wiped out as late as 1811 ([85], Volume 15, page 455), or a mere 40 years before Brugsch's zodiac was manufactured – 1853, according to the horoscope.

It appears that the tradition of burying the dead in the old Egyptian fashion had been kept alive by patriarchal Mameluke families for a considerable amount of time, with the XIX century instruments used for the creation of typical "ancient" Egyptian wooden coffins complete with an old-fashioned zodiac painted on the lid in traditional colours. The coffin would then be hidden. One would think these coffins were guarded well against thieves, but this wouldn't always succeed, since rich European collectors paid hefty sums of money for such coffins if they were presented as "exceptionally ancient". Therefore those who made a living stealing and selling the coffins in question were hardly in short supply. They would occasionally succeed, as was the case with the coffin studied by Brugsch. It is most likely to have been stolen shortly after the burial and instantly sold, to be shown to Brugsch in 1857.

Someone must have scribbled a horoscope for 1861 on the coffin lid in jest. One can hardly learn the identity of its author nowadays; however, this person clearly counted on the Egyptologists to decipher his horoscope and try to ascribe an antediluvian dating to it, ignorant of the coffin being modern.

It is clear why the hoaxer would use demotic script for the horoscope. He would need nothing for this purpose except for a fitting book on Egyptology – or a mere dictionary, mayhap. Demotic script was deciphered by Akerblad as early as in 1802 ([544], Volume 6, page 698). Thus, the forger must have been a contemporary of Brugsch; both used the same dictionary in order to write the cryptic inscription and to decipher it a year or two later.

One should hardly ascribe the subscript authorship to Brugsch himself the way N. A. Morozov does, albeit jocularly. The author of the subscripts must have been perfectly certain that neither Brugsch, nor any other specialist in Egyptian history would attempt to find the solution for this zodiac in the XIX century, thus remaining unaware of the real situation.

It is also possible that the horoscope was compiled for a future date several years in advance. Thus, Brugsch may already have seen the subscripts in 1857 which he claims to be the date of his first acquaintance with the zodiac in question ([544], Volume 6, page 695).

Astronomical calculations necessary for this purpose did not present a problem in that epoch, since it was already the second half of the XIX century.

Thus, we came up with the following solutions for Brugsch's zodiac (see fig. 13.17):

1) N. A. Morozov's solution:

The horoscope of demotic subscripts:
17 November 1682 A.D.
(the solution of 18 November 1861 A.D.
had been found, but rejected)
"Horoscope without rods": not found.
"Boat horoscope": not found.
(N. A. Morozov, [544], Volume 6, pages 694-728.)

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2) Our solution:

The horoscope of demotic subscripts:
18 November 1861 A.D.
"Horoscope without rods": 6-7 October 1841 A.D.
"Boat horoscope": 15 February 1853 A.D.

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5. ASTRONOMICAL DATING IN THE WORKS OF THE EGYPTOLOGISTS

Let us give a brief overview of the works written by various Egyptologists that are concerned with the astronomical dating of the Egyptian zodiacs. We consider discussing this issue in detail to be superfluous for the following reasons: firstly, these works are based upon the Scaligerian chronology to a great extent and thus have got nothing to do with independent astronomical dating, which is the topic of our research (see [1062] and [1062:1], for instance). Secondly, the analysis of astronomical symbols contained in Egyptian zodiacs is rather superfluous as carried out in these works. Its level is a great deal lower than that of the respective research conducted by N. A. Morozov. Furthermore, the examples of Egyptian zodiac analysis found in the works of Egyptologists postdating the publication of Morozov's book ([544]) usually demonstrate a great willingness to evade the problem of astronomical dating altogether from the part of the author. We have already discussed this above, citing [1291] as an example.

Another example that we would like to mention is the astronomical dating of the Round Zodiac of Dendera as offered by the Egyptologists in the fundamental monograph [1062:1]. This five-volume monograph was written by Sylvia Cauville, a French Egyptologist, in the 1970's, and is concerned with the ceiling artwork of the Dendera Temple exclusively, as one can gather from its title. In particular, it contains a discussion of the Round Zodiac's astronomical dating. A separate book by the same author is dedicated to this particular issue, namely, [1062], a condensed version of the monograph ([1062:1]). Let us point out that the astronomical dating of the Long Zodiac found in the same temple in Dendera isn't tackled anywhere in [1062] at all.

The very beginning of the section of [1062] entitled "The Dating of the Zodiac" makes it clear that the author isn't even going to consider a dating of the Round Zodiac that would be independent from the consensual chronology of Egypt. The discussion about astronomical dating begins with quotations from Egyptian chronology. For instance, in the first few sentences we find the categorical postulation that Ptolemy Auletes, the Egyptian king who had "renovated" the Temple of Dendera for the last time, had ruled during a certain explicitly specified epoch preceding the new era ([1062], page 11). This was followed by the reign of Cleopatra in Egypt, whose years are also "known to the Egyptologists perfectly well" ([1062], page 11). It goes on like this, and the categorical conclusion that the Round Zodiac from the Temple of Dendera dates to the interval between 51 and 47 B.C. is made prior to any mention of astronomy (*ibid*).

The role of the zodiac's astronomical analysis in [1062] and [1062:1] is a very insubstantial one – it serves to confirm the Egyptian chronology that is already known to the author of [1062] perfectly well one more time. Let us quote: "Partant de cette donnée assurée, E. Aubourg a cherché si, dans se laps de temps (51-43 av. J.-C.), la place des planètes parmi les constellations du zodiaque était astronomiquement possible" ([1062], page 11). S. Cauvilee is telling us that E. Aubourg, the astrophysicist, confirms the fact that the planetary positions in relation to the constellations presented on the Round Zodiac are "astronomically possible" for the period between 51

and 43 B.C. However, further explanations that we encounter in [1062] testify to the contrary.

Indeed, on the very next page of [1062] it turns out that the horoscope of the Round Zodiac, or a simultaneous combination of all the planets in the zodiacal constellations specified in the Zodiac didn't appear on the sky at any point on the interval between 51 and 43 B.C. as specified by the author. Therefore, in order to "confirm" the chronology of the "ancient" Egypt, the correlation between the Round Zodiac and the calculated star chart sought in [1062] indicates different dates for different planets, no less. Moreover – not all of the planets, but just two of them, qv in [1062]. It is quite obvious that such "astronomical proof" can be obtained for any a priori specified time interval spanning several years or more.

Thus, the correlation for Mars between the calculated star chart and the Round Zodiac is given for the 16 June 50 B.C. in [1062], page 12. The correlation for Mercury is for an altogether different date two months away – 12 August 50 B.C. (ibid). The interval is too great, considering the relatively fast ecliptic motion of Mars and even faster motion of Mercury, which can pass through two zodiacal constellations over this time.

The positions of other planets on the Round Zodiac aren't compared with the calculated star chart at all anywhere in [1062]. The circles symbolizing the Sun and the Moon are considered to stand for solar and lunar eclipses for some reason (see [1062], pages 19-22). This interpretation isn't validated anywhere in [1062] and appears to be most dubious indeed. Let us however assume it to be true for a moment. What are we being offered as an astronomical solution? Nothing of substance, as we shall duly witness.

Let us begin with lunar eclipses. Two candidates are suggested: the eclipse of 1 April 52 B.C. (maximal phase reached at 21:28 GMT) and that of 25 September 52 B.C. (maximal phase reached at 22:56 GMT). See page 20 of [1062] for details. However, none of these eclipses is total; they are ordinary astronomical events that happen almost every year. Let us point out that there is no exact correlation with the dates by Mars or by Mercury here – the difference equals two years. Once again, this proves nothing, since a partial lunar eclipse can be found on any time interval spanning several years; the observation point is also of little importance since one can observe lunar eclipses from any location upon the nocturnal surface of the Earth. It is hardly surprising that the author of [1062] should have found two such eclipses on the interval between 51 and 43 B.C. as specified a priori.

Let us now consider the solar eclipse. The "astronomical solution" that we find in [1062] names the solar eclipse that took place on the 7 March 50 B.C. at 11:10 GMT, allegedly "almost full" as observed from Dendera, qv in [1062] on page 22. However, the control calculations that we conducted demonstrated that the phase of this eclipse had been so minute in the Nile region that one would have problems observing it with the naked eye. The sky didn't darken; the track of the maximal phase of this eclipse lay hundreds of kilometres to the west from Nile. Once again, this presumed date of "astronomical concurrence" as offered by [1062] doesn't correspond to any dates suggested in [1062] earlier, qv above. Rough coincidence proves nothing since it also results from the fact that the search is conducted on a very narrow interval of 51-43 B.C. specified a priori. The probability of finding a partial solar eclipse on such an interval is high enough, since partial eclipses aren't that much of a scarcity. Let us point out that such events aren't visible to the naked eye and require a piece of shaded glass.

Apart from that, we must reiterate that the very fact of a solar eclipse represented on the Round Zodiac (likewise a lunar one) is highly dubious and not validated anywhere in [1062].

We shall cease with our study of the Round Zodiac's "astronomical dating" as performed in [1062] and [1062:1], since a list of all the contradictions and inconsistencies that can be spotted in [1062] would take up too much space. The same symbols are considered to stand for planets in one instant, and non-zodiacal constellations in another (see [1062], page 9). What we see is a recurrence of Heinrich Brugsch's old error in identifying Venus on the Round Zodiac. This error has been found a while ago and studied by N. A. Morozov in detail in [544], Volume 6, pages 652-653. And so on, and so forth.

And yet, as we have already seen, no strict astronomical solution for the Round Zodiac was found anywhere in [1062], even within the interval spanned by the tendentious interpretation offered by the author, with its multitude of inconsistencies and presumptions.

CHAPTER 14

A new approach to the decipherment of the Egyptian zodiacs

1. THE SHORTCOMINGS OF THE EARLIER DECIPHERMENTS OF THE EGYPTIAN ZODIACS

The independent astronomical dating of the Egyptian zodiacs has so far been following the following scheme:

The first stage involved a study of the symbols used in a given zodiac in order to decipher it and to pick out the horoscope. Even if various interpretation options were considered, researchers would still settle for a single one at the end, the one they would consider the best. This would usually be the option chosen as the initial data used for astronomical dating.

The resulting interpretation would then serve as basis for astronomical calculations. If the calculations yielded a single solution for the entire historical interval, the dating of the zodiac would be considered quite unambiguous. If not, one would presume the existence of several possible dating options. In the latter case, the choice of the final dating would usually be based upon considerations that had absolutely nothing in common with astronomical calculations.

Therefore, the researcher's primary objective would be to make the "best possible" selection of horoscope symbols from the Egyptian zodiac, and to decipher this horoscope correctly, which implies finding the signs for all seven planets, including the Sun and the Moon, and estimating the exact disposition of planetary signs in relation to constellation signs on the zodiac in question, which would yield the desired horoscope. Let us remind the reader that the Sun and the Moon were ranked among planets in ancient astronomy ([393], page 40).

The final astronomical dating of the zodiac depended on the solution of this problem in principle. After the discovery of all the planets, other symbols inherent in the Egyptian zodiac would usually be left unnoticed and at best referred to in a few short lines that would usually ascribe some vague pseudo-religious meaning to them, or declare them to stand for "comets". This is also what N. A. Morozov had done – possibly following some earlier Egyptologist "research". Later authors who based their research on Morozov's works didn't mention these "non-horoscope" symbols found on Egyptian zodiacs. They would usually merely quote Morozov's opinion in re this or the other "extraneous" symbol.

The concept of this approach is simple and understandable in general. Indeed, if all the planets are already located on the zodiac, the horoscope is exhausted, and one would think that no extra astronomical data are required for the zodiac in question – at the very least, there should be no "odd planets".

We shall demonstrate this to be incorrect. The astronomical content of the Egyptian zodiacs is of a lot more complex nature than it appears to be – in particular, one finds a great deal more astronomical symbols that it has been assumed previously. Our study demonstrates that apart from the primary horoscope, whose search and interpretation had been the only goals inherent in previous research, Egyptian zodiacs tend to contain several "secondary" horoscopes of a partial nature, which are incomplete and refer to fixed dates of the same year as the primary horoscope.

This fact has so far remained beyond the attention scope of researchers, which would urge them to think of far-fetched explanations for the meanings of the "extraneous" (according to their opinion) planetary symbols on Egyptian zodiacs. However, these symbols are really the furthest thing from "extraneous".

It turns out that many of the symbols found on the Egyptian zodiacs that have so far been considered "non-astronomical" possess explicit astronomical meaning nevertheless. In many cases this provides us with a substantial amount of data to complement the primary horoscope of the Egyptian zodiac. Combined, they usually suffice for eliminating all the unwanted solutions that we might come up with in the process of dating the horoscope in question astronomically. Note that unwarranted solutions might result from multiple recurrences of a given planetary combination as well as errors in horoscope decipherment. Without additional astronomical information we are sometimes incapable of distinguishing between the extraneous solutions and the real dating (if we're guided by nothing but astronomical considerations, that is).

It is important that the presence of extra astronomical data in Egyptian zodiacs (which can be considered "reference data", after a manner) presents us with new opportunities that our predecessors didn't have, since they actually rejected a substantial part of astronomical symbols found in the Egyptian zodiacs. Out of all the new opportunities that we have now, the one that has to be mentioned first and foremost is *the opportunity to account for all possible horoscope interpretation options at once.* We are thus liberated from the necessity to ponder (and often in the most dubious manner indeed) why one of the zodiacal interpretations should be better or worse than the other.

Let us expound this further. Why would extra astronomical data contained in the zodiacs allow us to consider a variety of interpretation options simultaneously, and why has it been impossible so far? And just why would that be impossible? The answer is that ambiguity and a multitude of horoscope interpretation options would inevitably lead to several astronomical solutions found on the historical interval. Should we possess no extra information, we shall simply lack the possibility to choose the single correct solution out of several variants. If we do have such information, it can be used for the purpose of eliminating the random solutions of the primary horoscope. Indeed, let us do the following – we shall make astronomical calculations for all possible interpretations of the zodiac first, which shall leave us with a certain range of possible solutions, or datings, and probably a rather broad one at that. We shall then discard all the datings that fail to correspond to the extra information found in the zodiac. As we shall see below, this usually leaves us with a *single* solution – that is, the only possible dating for the Egyptian zodiac in question found on the entire historical interval. It is only in cases when this extra information comes in insufficient amounts or when the zodiac is in a very poor condition when there are several solutions; however, there are very few such cases.

Below we shall discuss our new approach to the dating of Egyptian zodiacs in more detail. In the present section we provide several examples to illustrate how these "extraneous" symbols that didn't pertain to the main horoscope were referred to previously – it is, after all, obvious that when the researchers would come across these symbols, they would have to explain their presence on the zodiacs in some manner. This would leave to omissions or distortions whose nature only becomes clear to us today.

Let us point out that N. A. Morozov's opinion on the "extra-horoscope" symbols on the Egyptian zodiacs hasn't drawn any criticisms in publications on non-Scaligerian chronology as to yet. However, it becomes clear now that he made several serious errors here. It shouldn't compromise the quality of the Egyptian zodiacs' analysis carried out by N. A. Morozov. He had voiced many important and deep ideas on the interpretation of Egyptian astronomical symbols. Most of such ideas turned out to be correct and

Fig. 14.1. Jupiter is represented by two figures in the Round Zodiac of Dendera (DR), according to the interpretation of N. A. Morozov. They are the two wayfarers with rods next to Cancer. These figures, as well as the constellation symbols, are highlighted: the figures are covered by dots, and the symbols of constellations are shaded grey. One sees the constellations of Virgo, Leo, Cancer and Gemini. It is obvious that if one of the rod-bearing figures becomes lost, it will instantly affect the position of Jupiter in relation to the constellations. The planet will be shifted into Leo or Virgo – or, possibly, even Gemini. Therefore, N. A. Morozov's presumption that what we have in front of us is a double representation of Jupiter made "for the sake of security" appears most suspicious indeed. In Chapter 17 of CHRON3 we shall demonstrate that the wayfarer on the side of Virgo isn't Jupiter, but rather Mercury in a secondary horoscope. The one we find on the side of Gemini is indeed Jupiter in the primary horoscope, just as Morozov had supposed. Both figures have hieroglyphic inscriptions over their heads; those contain the names of the planets. Sebek, for instance (or SBK) was the name used for referring to Mercury. See CHRON3, Chapter 17 for more details. Taken from [1062], Chapter 71.

shall be used in our research. Nevertheless, many of the symbols present in the Egyptian zodiacs were neglected by N. A. Morozov, who had adhered to the erroneous opinion that these symbols bear no relevance to the actual horoscopes and cannot affect the results of astronomical dating. This may be explained by the fact that Morozov was under the influence of the general interpretation scheme used for Egyptian zodiacs that had already been developed in his epoch. His approach would therefore inherit some of the shortcomings inherent in the scheme.

Before we get to actual examples, we must make the following general observation concerning prior interpretations of the Egyptian zodiacs, including those made by Morozov. It turns out that in almost every case when the "gods" or the "goddesses" that one presumably finds in Egyptian zodiacs are mentioned, we observe a lack of comprehension in what concerns the Egyptian astronomical symbols. The reason is that the researchers would periodically run into "extraneous" symbols in their analysis of the Egyptian zodiacs as carried out in accordance with the classical approach – "extraneous" since they weren't required for the horoscope, that is. However, they would still be found in zodiacs and needed to be explained in some way. One of the easiest solutions is to declare that these symbols represent "ancient Egyptian deities" and to close the subject without unnecessary complications.

Another way of writing off the extra planetary symbols is to declare that the latter represent comets and not planets – another mobile luminary that resembles a planet in this respect since it also moves amidst the stars. Therefore, a comet "manifest as a planet" upon an Egyptian zodiac is a plausible phenomenon. On the other hand, apart from a very few exceptions, comets are quite beyond astronomical calculations, and it is therefore impossible to prove the presence or absence of a comet upon the celestial sphere in a given year - to calculate the advent of new comets unknown as to yet, for instance, or, alternatively, the ones that already disintegrated, but could be observed previously. It is thus obvious that, for want of a better solution, a "redundant" planetary symbol could always be written off as a comet. N. A. Morozov would use this method rather often.

However, below we shall demonstrate that there are no comets on any Egyptian zodiacs known to us – represented with the same symbols as the planets, at least.

Let us consider several actual examples of such "extraneous" symbols as found in the Egyptian zodiacs and explained in the works of N. A. Morozov.

We shall consider the interpretation of the Round Zodiac of Dendera found in Volume 6 of [544]. There are so many secondary symbols in this zodiac that N. A. Morozov was forced to make the assumption that "each of the planets, excepting Mercury, two-faced by nature, is represented by two figures in its re-

spective constellation" ([544], Volume 6, pages 659 and 666).

Further text by N. A. Morozov demonstrates that its author was perfectly aware of just how far-fetched this assumption of his about duplicated planets on the Round Zodiac had really been, and so he provides several different explanation of this odd duplication in a rather embarrassed manner – a propos, we find nothing of the kind on any other Egyptian zodiac. As a matter of fact, Morozov himself refutes all these explanations of his one by one.

"Wherefore two figures? Possibly, so that the Zodiac would not become illegible should one of the figures be harmed" is what Morozov tells us. However, this is a poor explanation, since according to Morozov himself, the figures used for the same planet are often located at a considerable distance from each other – the "doubles" of Jupiter, for instance, are an entire constellation apart (see fig. 14.1). Thus, should something happen to one of the figures, the other one "alone" shall merely misidentify the planetary position. What "additional security" can we possibly talk about here, pray? Had this "reserve duplication" indeed been the case, the "doubles" would be close to each other – in the same constellation at the very least. However, this is not the case with the Round Zodiac. Therefore, N. A. Morozov instantly suggests another explanation – "this could result from rear figures referring to the planetary positions for the beginning of the sculpture's creation, and the ones in front – to the respective positions for the time when the sculpture would be finished". However, this explanation also doesn't appear too plausible, which is immediately pointed out by N. A. Morozov himself: "However, the suggestion that the artist wanted to demonstrate how they shifted over the time of modelling doesn't make much sense, since this shift would be too great for Jupiter and Saturn, and too small for Venus and Mars for an equal number of days".

Morozov is forced to conclude with the rather vague idea that "it [or the separation of the "duplicated" planets – Auth.] may be ascribed to the time when the construction of the entire building had begun and ended, several years at the very least" ([544], Volume 6, page 666). Needless to say, N. A. Morozov doesn't offer any calculations to validate this "finite explanation" that he offers us, which we could rightly expect from his part, had he really been right in this case.

A propos, as we shall discuss in detail below, and as N. A. Morozov himself explained rather comprehensively in [544], Volume 6, double symbols could, and often did, stand for just two planets – Venus and Mercury, due to the fact that these planets are interior and can only be seen from Earth at dusk and at dawn, in their matutinal and vespertine incarnation. In Mercury's case, this "ambiguity" would often become translated as two faces on Mercury's figure. As for Venus, it is also often represented as two figures, one near the other, which is the case with the Round Zodiac where we see it drawn as two female figures in long dresses, one following the other (see fig. 14.2).

However, these "double symbols" aren't really applicable to any other planets except for Venus and Mercury, and would thus be a most peculiar thing in their case, especially with these symbols being at a considerable distance from each other. It is natural that when researchers came across these "duplicated" planetary symbols on Egyptian zodiacs, they would do all they could in order to get rid of them, failing to realize that these "extraneous" planets represent important additional information important for dat-

Fig. 14.2. Venus in the Round Zodiac of Dendera (DR) is drawn as two female figures with rods, apparently travelling together. On the left one sees a modern photograph with the same fragment of the Round Zodiac on it. Mark the figure of two little beasts with their backs grown together and the tail of the figure hanging down towards Aries and Venus. Morozov was of the opinion that the symbol represents the dusk and the dawn; we consider him to have been correct ([544], Volume 6, page 659). We see a similar figure next to Venus and Mercury in the Round Zodiac of Dendera. Taken from [370], page 165 (photograph) and [1062], page 71 (drawn copy).

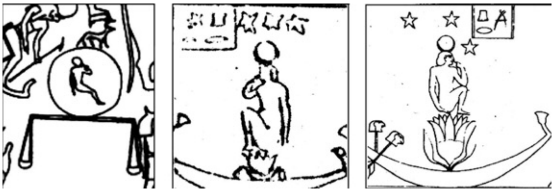


Fig. 14.3. Astronomical symbolism of the zodiacs found in Dendera. On the left one sees the symbol of Libra from the Round Zodiac of Dendera (DR). In the middle we find the lunar symbol from the Long Zodiac according to the drawing from Bode's ***Uranography***, and on the left there is the same symbol from the drawn copy of the Long Zodiac (DL) as given in the Napoleonic album ([1100]). One can plainly see that the naked figure sucking on a finger is one and the same in all three drawings. The finger in mouth symbolises the infantine age of the Moon. Taken from [1062], page 71 (left drawing), [544], Volume 6 (inset following page 672 – drawing in the middle), and [1100], A. Vol. IV, Pl. 20 (drawing on the right).

ing purposes. These attempts to exclude these planets were of an erroneous character, and would naturally result as imprecise interpretations, as is the case with Morozov's explanation quoted above when the alleged double figures of Jupiter actually ended up in different constellations.

Another vivid example is how N. A. Morozov interpreted the sign that looked like a circle with a human figure in the middle as seen in the constellation of Libra on the Round Zodiac.

Before relating this in more detail, let us explain that the Sun and the Moon were drawn on Egyptian zodiacs as circles; occasionally these circles would contain some symbol. Indeed, the Sun and the Moon are the only luminaries than one sees as circles and not dots. We already mentioned the fact that both the Sun and the Moon would be referred to as planets in mediaeval astronomy, although they aren't anymore ([393], page 40). It shall nevertheless be convenient for us to use the term "planets" the way ancient astronomers did. This term is misleading, yet it facilitates the narrative in our case, since it corresponds to the astronomical concepts that the Egyptian zodiacs are based upon.

The above should seemingly imply that two circles (one for the Sun and the other for the Moon) are the absolute maximum for an Egyptian zodiac – however, we find many of the latter to contain more than two. For instance, we see three circles in the row of zodiacal constellations on the Round Zodiac of Dendera – two in Pisces and one in Libra, qv in fig. 12.9 above. The Long Zodiac sports four such "solar/lunar" circles, or two times more than the norm.

This circumstance made N. A. Morozov resort to making rather far-fetched explanations of the Egyptian zodiacs. For instance, in order to eliminate the circle in Libra on the Round Zodiac of Dendera that he had considered an arbitrary addition, Morozov had to interpret it as the representation of an "ancient Egyptian goddess", which was done rather clumsily, and also inconsequentially.

Let us linger on this for a short while, since we shall be referring to this instant in our analysis of the symbols contained in the Egyptian zodiacs. In his analysis of the Round Zodiac of Dendera N. A. Morozov wrote that "over the figure of Libra we see a circle with the goddess of Justice inside" ([544], Volume 6, page 658). Morozov must have thought that since the "extraneous" circle was located in Libra, it would make sense to refer to the figure contained therein as to the "goddess of Justice", since the scale symbolizes justice.

It is however rather odd that this alleged "goddess of Justice" should be drawn naked, and holding a finger in her mouth at that, qv in fig. 14.3. Furthermore, an attentive study of the Dendera zodiacs demonstrates that a perfectly similar figure (naked and holding a finger in its mouth) can also be seen on the Long Zodiac of Dendera, where it explicitly and unequivocally symbolises the *young moon* and not a "goddess of Justice" of any kind. Morozov himself points this out. We see the lunar circle upon the figure's head, with a distinctly visible crescent in it. This lunar figure from the Long Zodiac can be seen in the same fig. 14.3, both of its versions simultaneously – one comes from Bode's drawing as used by N. A. Morozov, and the other was made by Napoleon's artists and was taken from [1100]. It is plainly visible that the figure of Moon from the Long Zodiac is completely identical to the "goddess of Justice" from the Round Zodiac.

A naked figure holding a finger in its mouth appears to be a perfectly natural symbol, since this very finger referred to childhood in ancient Egypt ([1051:1], page 74). The figure's infancy is also em-

phasized by its nudity, since the Moon is either "young" or "old", "newborn" or "dying". We don't use these terms for any other stars or planets; none of them can be "young", unlike the Moon. N. A. Morozov is perfectly correct to point out the following in his discussion of the Long Zodiac: " … the girl in front has the Moon on her head. The figure's childhood is also emphasized by the absence of a bust and the hand held in the mouth" ([544], Volume 6, page 658). However, N. A. Morozov modestly refrained from mentioning the age of a similar girl holding her hand in her mouth as seen on the Round Zodiac – possibly to avoid emphasizing just how far-fetched his presumption concerning the "goddess of Justice" in Libra on the Round Zodiac really was.

One can naturally counter with the presumption that the "ancient" Egyptians may have used the same symbol for both the moon and some mysterious goddess that bore no relation to astronomy in both zodiacs. This is possible – however, a presumption as ambiguous requires proof, since both zodiacs are located in the same Egyptian temple and are thus most likely to use a common set of symbols.

At any rate, it is obvious that the version with the Moon in Libra on the Round Zodiac needs to be considered and studied amongst other possible interpretation options at the very least – however, Morozov fails to do this, and it is easy to understand why – because he had already found another symbol for the Moon, and a very appropriate one at that; as for the possibility of there being two moons on the same zodiac, he had not allowed for it, which was a mistake.

Another example. In his interpretation of the symbols found on the Long Zodiac of Dendera, N. A. Morozov writes the following, in particular: "then we see some person dressed as a high priest and carrying a serpent preceded by another man *holding the rod of a vagrant luminary, or the symbol of a comet* in the evening sky ([544], Volume 6, page 677). In fig. 14.4 one can see the fragment of the Long Zodiac that Morozov is referring to herein – the male figure on the left with a planetary rod in its hand and a star above its head. Such figures always stand for planets in Egyptian zodiacs, and this circumstance was frequently pointed out by Morozov himself (see [544], Volume 6, page 956, for instance). However, the problem here is that this figure is an "extraneous" planet,

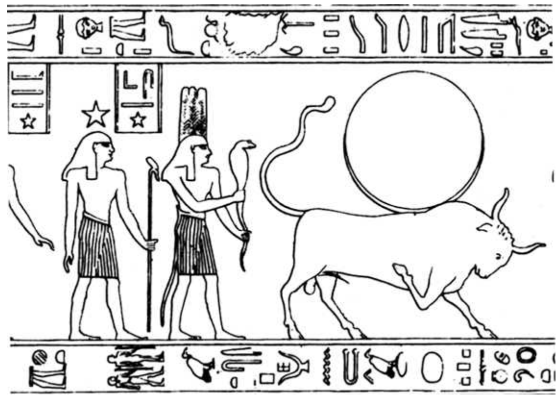


Fig. 14.4. The Long Zodiac of Dendera (DL). A fragment of the drawn copy from the Napoleonic album on Egypt. The man on the left is carrying a planetary rod and has got a star over his head. Such figures represent planets in Egyptian zodiacs. However, all of the planets from the Long Zodiac have already been found by N. A. Morozov, who had suggested to consider this "extraneous" planetary figure a comet, despite its being a typical planetary symbol from an Egyptian zodiac. Taken from [1100], A. Vol. IV, Pl. 20.

since N. A. Morozov already managed to find all seven planets in other places of the same zodiac. Therefore, Morozov's approach leaves him with no other option but to consider this figure a comet despite its planetary symbolism. However, this presumption of Morozov's isn't backed up by anything at all, albeit it is possible in principle. However, below we shall expose this presumption as erroneous, proving that the figure in question represents a planet the way it should.

This is far from the only "comet" that was "successfully discovered" in the Long Zodiac by N. A. Morozov. He found yet another comet there – once again, when he had inadvertently come across a symbol unrelated to the horoscope. The very same page where we encounter the reference to a comet contains the following passage a few dozen lines below: "Gemini are followed by the girl marking the first ten grades of Cancer. Then we see the young man inside a boat carrying a rod that is already familiar to us – some comet" ([544], Volume 6, page 677, fig. 14.5). Thus, the "redundant" astronomical symbol of the Egyptian zodiac becomes a "comet" once again, without any evidence whatsoever to back it up. Below we shall demonstrate the symbol to stand for the summer solstice.

By the way, a rougher version of the same sign was

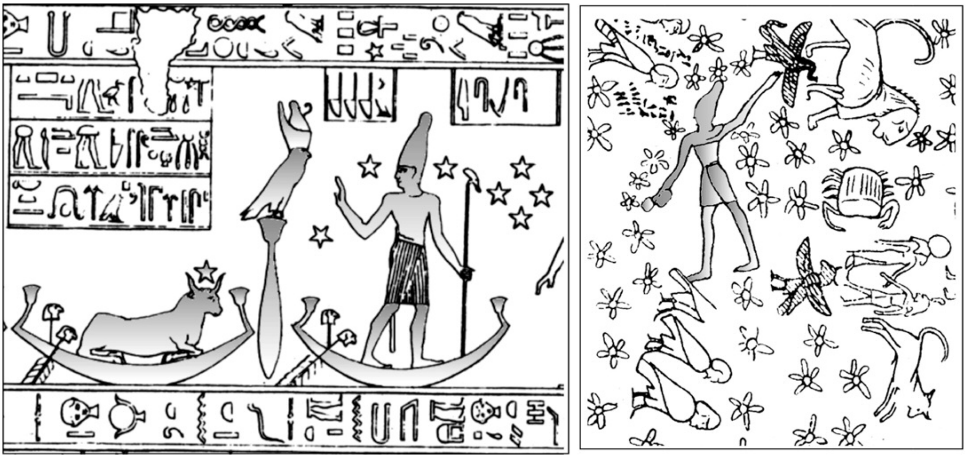


Fig. 14.5. Fragments of the Long Zodiac from Dendera (DL) on the left, and the Lower Zodiac from Athribis (AN) on the right. In both of them we see the figure of the man with his hand raised into the air in Gemini; it symbolises the summer solstice point that is located in this constellation. The bird on top of a pole (left) is also a summer solstice symbol, referring to the highest position reached by the Sun in the sky. The drawing is made according to drawn copies from [1100], A. Vol. IV, Pl. 20, as well as [544], Volume 6, page 730. Symbols that bear no relation to the primary horoscope are shaded in grey.

encountered by Morozov on the Athribis zodiacs as well; however, on that occasion he decided it should represent the constellation of Orion and not a comet, writing that "the constellation of Orion … is depicted as a man who raises his right arm, inviting the souls to ascend into heavens" ([544], Volume 6, page 729). In fig. 14.5 one can see fragments of the Long Zodiac and the Lower Zodiac of Athribis referred to herein. This is yet another error of N. A. Morozov explained by his inability to comprehend the extra-horoscope symbols inherent in Egyptian zodiacs. The symbol in question is found in many Egyptian zodiacs and represents the point of summer solstice.

By the way, we see another symbol of the summer solstice on the Long Zodiac next to the man with his arm raised – a bird on a perch. This symbol also hadn't been recognized by Morozov, who didn't even mention it here (fig. 14.5). Nevertheless, we find the very same symbol on the Round Zodiac of Dendera, where it looks just the same and occupies the same astronomical position at the point of summer equinox (fig. 14.6). This time Morozov doesn't leave the perched bird unmentioned, saying that "the bird is followed by a sceptre with a falcon upon it wearing the headdress of a high priest, signifying the high rank of the leader of this procession" ([544], Volume 6, page 669). Obviously enough, N. A. Morozov has once again misinterpreted the summer equinox symbol as a mysterious "sceptre" of some sort, one that presumably takes part in some "procession", and quite autonomously, at that (see fig. 14.6).

The figure with the rod that heads this procession is also presumably unable to be a part of the horoscope, since N. A. Morozov already managed to identify all the planets successfully. The only way out that Morozov finds is to resort to the same old trick – consider the "extraneous" planetary figure a comet. According to him, "all of this signifies that in 568 A.D. [the year N. A. Morozov dated the Round Zodiac to – Auth.] a great meaning was attributed to some comet" ([544], Volume 6, page 670). Morozov even managed to find a fitting comet from the "ancient" Chinese astronomical chronicles allegedly dating to 568 A.D. ([544], Volume 6, page 670). This shouldn't surprise us – if we're to believe the "ancient" Chinese records concerning comets, we must also believe that the "ancient" Chinese chroniclers observed a comet nearly every year, although comets visible to the naked eye are a very scarce phenomenon indeed. To put it bluntly, one can find a "fitting comet" for almost every year in the "ancient" Chinese lists; the matter is that these actual lists are a recent forgery (see our analy-

sis of the Chinese comet lists in CHRON5, as well as the book ***Empire*** ([EMP]).

Once again we see that N. A. Morozov cannot provide any adequate explanation for the non-horoscope astronomical symbols that he finds in Egyptian zodiacs.

We shall cease with listing the examples of how Morozov tried to "explain" the existence of certain enigmatic signs in Egyptian zodiacs which could not be understood with his approach. Let us reiterate that this approach was not an invention of N. A. Morozov – he had borrowed it from earlier works of the XIX century Egyptologists and astronomers.

It goes without saying that N. A. Morozov had performed a great and very useful body of work in order to bring this approach to perfection, having introduced many corrections and valuable novel concepts.

However, N. A. Morozov did not revise the classical approach to the interpretation of Egyptian zodiacs in general. Likewise his predecessors, he had been of the opinion that an Egyptian zodiac can only contain one horoscope – possibly, with some mystical symbolism added thereto that would be in do direct relation to astronomical dating. This isn't so, and this had been the error of the classical approach overlooked by Morozov.

Still, the level of calculating opportunities available to Morozov in his day and age had apparently been insufficient for compensating for some principal shortcomings of the classical method since it would require calculations exceeding the opportunity limits of those years. Such calculations require modern computers.

The following needs to be said about comets – as we have seen, N. A. Morozov would often appeal to them in order to explain the presence of "excessive" planetary symbols in Egyptian zodiacs ([544], Volume 6, pages 652 and 677).

An observable comet is a very rare event. People in "ancient" Egypt died every day, the way they do nowadays; there were very few of those who died in the year when a bright comet visible to the naked eye would appear in the sky. Therefore, the presence of a comet in a funereal zodiac should be regarded as an outstanding event; therefore, the probability that we shall encounter a zodiac with a comet among the two or three dozens of ancient Egyptian zodiacs that have survived until the present day is very low. Yet Morozov would occasionally discover a whole two comets on the same zodiac, in its different parts ([544], Volume 6, page 677). As we have mentioned, this resulted from his incomplete understanding of the astronomical symbolism of Egyptian zodiacs.

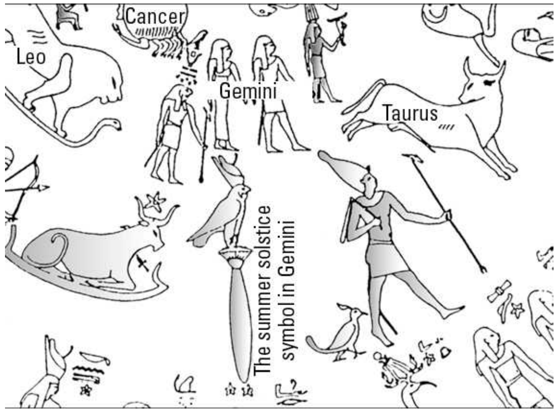


Fig. 14.6. A fragment of the Round Zodiac from Dendera (DR) with the summer solstice symbol that looks like a bird on a pole in the constellation of Gemini ([544], Volume 6, page 669). The figure with the rod on the right is a planet that doesn't relate to the primary horoscope, which was mistaken for an unidentified comet by N. A. Morozov. Symbols shaded grey aren't part of the primary horoscope. Drawing made in accordance with the drawn copy from [1062], page 71.

Let us conclude with the following note.

The present section was primarily referring to the works of N. A. Morozov. The works of other authors on the topic of interpreting the Egyptian zodiacs based on Morozov's book ([544], Volume 6) were not discussed due to the fact that the researchers who carried on with Morozov's research in the field of dating the Egyptian zodiacs also adhered to the classical interpretation of their astronomical meaning (see [912:3] and [376]).

The main goal in this approach is the location of the horoscope in the zodiac; the rest of the zodiac's content would be discarded as useless. In other words, the researchers were making the a priori presumption that the Egyptian zodiac can be rendered to its horoscope with enough precision to include all the data necessary for the purposes of astronomical dating.

This turned out to be incorrect. Additional symbols found in Egyptian zodiacs aren't "extraneous ob-

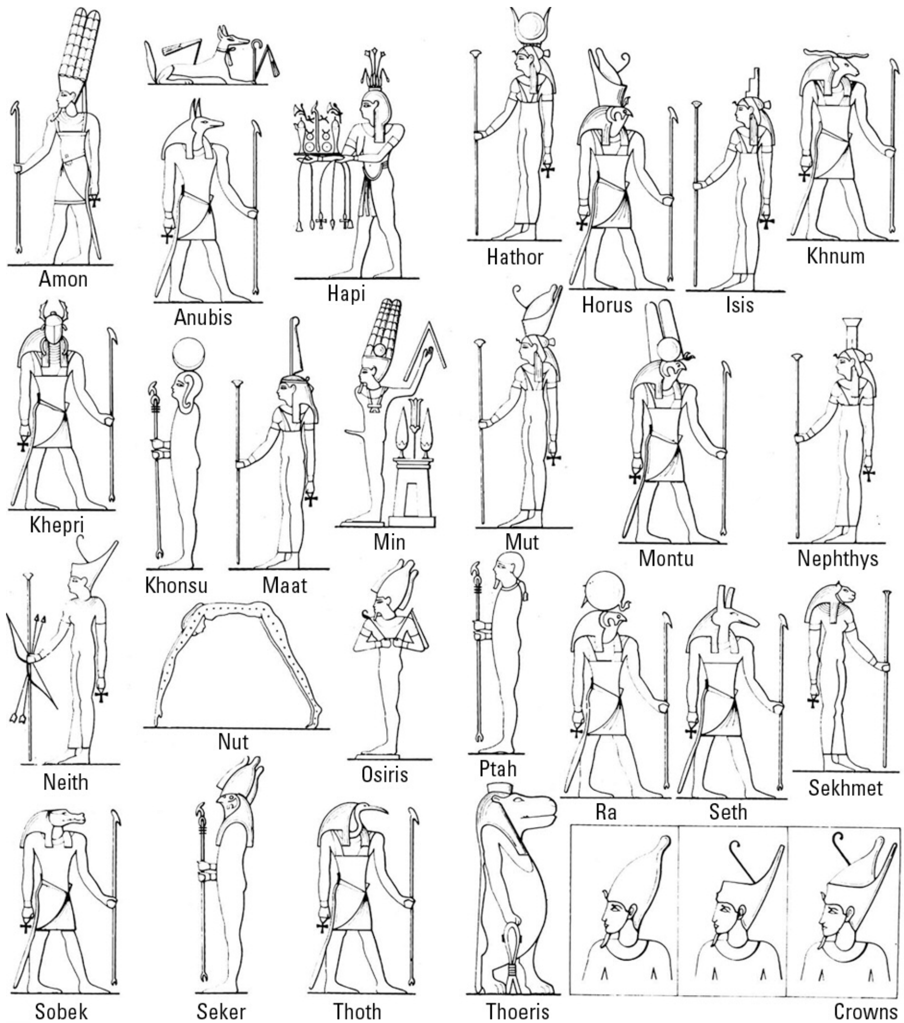


Fig. 14.7. Table of "Egyptian deities" from the book entitled ***The Entire Egypt***. The absolute majority of these so-called "deities" have an exact astronomical meaning – at the very least, those equipped with planetary rods. This is how planets were drawn in Egyptian zodiacs. Taken from [2], pages 10-11.

stacles" vested in very vague astrological meaning, but rather important astronomical information supplementing the primary horoscope.

However, this is far from all. We found out that a single Egyptian zodiac can contain several full horoscopes referring to several dates – those of the birth and death of the deceased, for example. Let us remind the reader that the Egyptian zodiacs were predominantly sepulchral in character. The respective examples shall be provided below.

We have not discussed the works on the astronomical dating of zodiacs written by Egyptologists. Let us mention them briefly.

In the preceding chapters we mentioned that the main shortcoming of these works is that they're a priori based on the Scaligerian chronology and wholly dependent thereupon; their authors don't so much as attempt an independent astronomical dating of the Egyptian zodiacs. Furthermore, the works of the Egyptologists that followed Morozov's research be-

tray a great reluctance from the part of their authors to delve into the subject of dating the Egyptian zodiacs astronomically. The actual topic is only mentioned in a few passages, and very superfluously so, as something of secondary importance as compared to the "historical" datings of the very same zodiacs. Above we already studied the examples of astronomical interpretation and dating culled from the works of famous Egyptologists ([1291] and [1062:1]).

We have also witnessed that whenever Egyptologists discuss the astronomical symbols contained in the Egyptian zodiacs, most of their attention is focussed on their alleged mystical or pseudo-religious allusions as opposed to their actual astronomical meaning ([1291]). This is hardly surprising. References to astronomy are to direct and hence potentially dangerous for the "ancient" Egyptian chronology, since they might yield actual datings of zodiacs as a result, and such datings might prove completely at odds with the Scaligerian chronology of Egypt. The fact that this is indeed the case became obvious after the publication of N. A. Morozov's works.

One might say that Egyptologists are unlikely to read Morozov's books. This might be so; yet it is hardly a coincidence that they became particularly evasive in what concerns the astronomical topic of the Egyptian zodiacs. This used to be different before Morozov's publications – the problem of dating the Egyptian zodiacs astronomically would be discussed by the Egyptologists actively. However, after Morozov's research all their references to the Zodiacs come down to hazy pondering of their mystical and religious meaning, whose alleged profundity only became revealed to the specialists after many years of meditation and meticulous scientific research.

This might be true to some extent. After all, ancient symbols often have a plethora of meanings. However, all such pseudo-religious or mystical interpretations are of zero utility to chronology since they cannot lead to any tangible results by definition.

Let us cite the figure table of the so-called "Egyptian deities" from the modern edition entitled ***The Entire Egypt*** ([2], fig. 14.7). Most figures of these "deities" were taken from ancient Egyptian zodiacs and other astronomical texts from the "ancient" Egypt. As we shall see below, almost all of them possess exact astronomical meaning – the ones equipped with planetary rods, at least. This is how planets were represented in Egyptian zodiacs, and this fact is known to the Egyptologists perfectly well ([1062:1]).

However, the compilers of the popular edition ([2]) didn't utter a single word about astronomy citing this most remarkable table of "Egyptian deities" which is made up of astronomical symbols predominantly – possibly under the assumption that the subject were too dangerous for the average reader, who might become interested, after all, and develop the "heretical" urge to unravel the astronomical contents of the "ancient" Egyptian texts unaided, or even attempt to date them independently, which would be the most perilous indeed.

Egyptologists have been perfectly aware of the possible consequences ever since the publication of Morozov's works. This may be the exact reason why they are extremely cautious and timid when they refer to the Ancient Egypt in the context of astronomy, changing the subject to that of "ancient" Egyptian mysticism at the first opportunity – and, as a matter of fact, the concept of this very "mysticism" as related by the Egyptologists is highly dubious, but perfectly safe for the Scaligerian version of Egyptian history.

The rendition of the Egyptologists is as follows: the content of Egyptian zodiacs had allegedly been very far from actual astronomy, and the "ancient" Egyptians would only think of the sky, the stars and the planets in the poetic sense when they were drawing their remarkable zodiacs, using them as a pretext to draw even more of their deities.

Our opinion is that such "explanations" explicitly distract the reader from a topic as interesting as it is dangerous for the Scaligerian chronology of Egypt.

2. A NEW APPROACH TO THE INTERPRETATION OF EGYPTIAN ZODIACS. PRIMARY AND SECONDARY HOROSCOPES

In the present section we shall give a brief outline of the new approach to the interpretation and dating of the Egyptian zodiacs.

At the beginning of our research, before we began the work with actual zodiacs, we conducted a meticulous comparative analysis of all the symbols contained in Egyptian zodiacs and available to us with

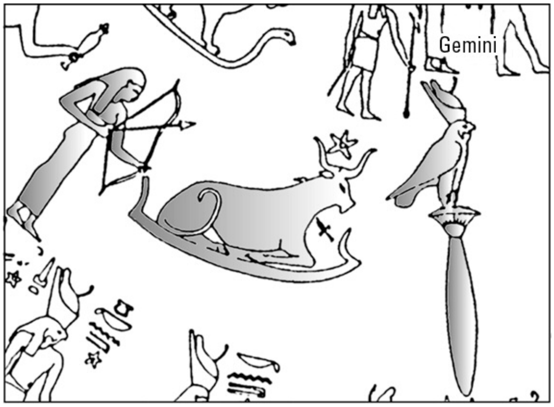


Fig. 14.8. Fragment of the Round Zodiac of Dendera (DR). The symbols shaded in grey are as follows: 1) pole (with a bird), and 2) incumbent bull (and a woman). These symbols are located right over the sign of Gemini, the "pole with a bird" being exactly above the constellation symbol. This drawing is based on the drawn copy from [1062], pages 9 and 71.

the purpose of deciphering them to as full an extent as possible.

Let us emphasize that this analysis was based on all of the Egyptian zodiacs known to us – not to one or two, or even several "related" ones. It turns out (although this was far from obvious initially) that the astronomical symbols used in the overwhelming majority of Egyptian zodiacs are the same. This is a very important circumstance that eventually allows a more complete understanding of the nature of Egyptian zodiacs than one could ever get from the works that preceded ours. We need to point out that the authors that have worked with Egyptian zodiacs previously would usually just study them separately; they only made a few attempts of comparing symbols from different zodiacs to each other in their research.

It is only after we perform such an analysis that we can proceed with the decipherment and dating of individual zodiacs.

Let us linger on it for a while.

Whenever we get acquainted with various types of old Egyptian zodiacs, we come up with the natural question of whether the symbols found in *all* of these zodiacs can be deciphered in order for all the figures from all the zodiacs to mean the same thing in every case? It would naturally require correspondence to some sort of astronomically valid picture that could really be observed on the celestial sphere during the historical epoch. Our answer to this question is in the positive; it is indeed possible to accomplish this in a single possible manner and to get unequivocal datings as a result.

We must emphasize that this answer is far from being self-implied. In theory, it is possible that the an-

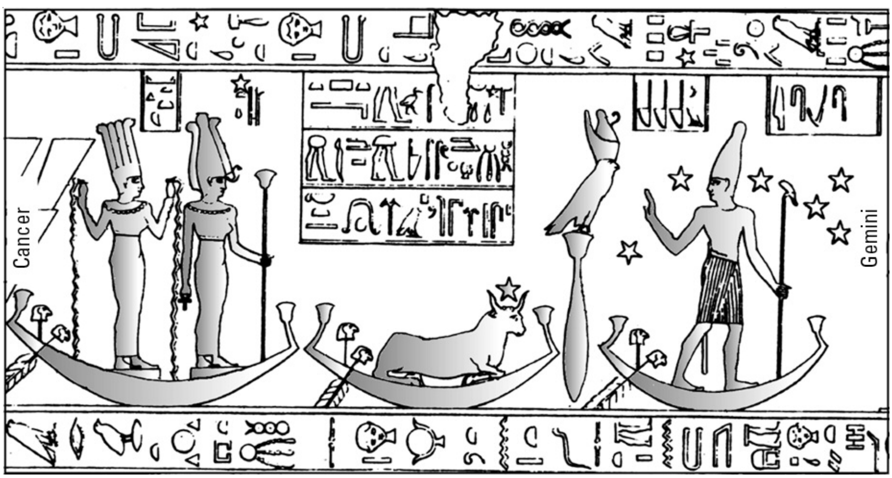


Fig. 14.9. A fragment of the Long Zodiac (DL). The symbols we see shaded in grey are as follows: 1) "man with his arm in the air", 2) "pole with a bird" and 3) "incumbent bull (and women)". Here we see two women instead of one next to the bull – they're standing in a separate boat. This entire symbol group is located between the signs of Gemini and Cancer (directions are indicated in the drawing). The drawing is made according to the drawn copy from [1100], A. Vol. IV, Pl. 20.

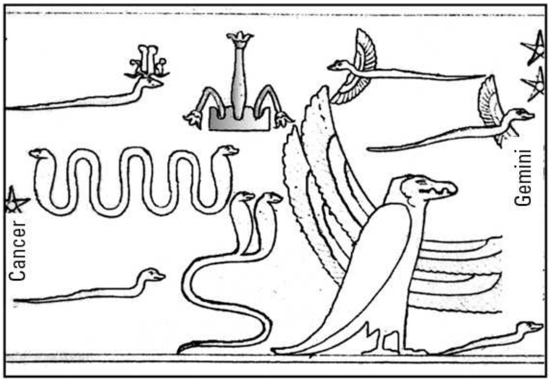


Fig. 14.10. Fragment of the EB zodiac from the Greater Temple of Esna. The "pole" symbol (with two broken poles on its sides) is shaded in grey. It is located between the signs of Gemini and Cancer, likewise in the Long Zodiac of Dendera. We see constellational directions indicated on the left and the right of the drawing. The drawing is based on the drawn copy from [1100], A. Vol. I, Pl. 79.

cient Egyptian artists were using astronomical symbols chaotically, ascribing different meanings to the same symbols used in different zodiacs. However, had this really been the case, our approach would simply yield no result at all – we would be most likely to come up with no solution and no interpretation in this case, or, alternatively, with planetary combinations that would be impossible from the point of view of astronomy – at the very least, a star chart that wouldn't refer to any moment on the historical interval. However, none of the above is the case. It turns out that Egyptian zodiacs can indeed be deciphered with the use of a single set of astronomical symbols. All of the interpretations have astronomical meaning and yield dates that fall into the historical interval.

The logical consequence is that the idea about Egyptian zodiacs being mere astronomical fantasies of the ancient artists is perfectly wrong. Had this been the case, it would be virtually impossible to decipher all of the Egyptian zodiacs using a single table of astronomical symbols in such a way that each time they would yield a sensible star chart that could really be observed during the historical epoch. The impossibility of such a situation results from the fact that the astronomical content of Egyptian zodiacs is rather rich, which makes the "fantasy" theory completely absurd.

We have discovered the Egyptian zodiacs to be perfectly professional astronomical texts transcribed as symbolic drawings. Astronomical symbols in Egyptian zodiacs would always follow a rigid order, with every symbol always meaning the same thing in the same context (although different symbols could naturally represent the same phenomenon).

Fig. 14.11. The Lower Zodiac from Athribis (AN, a fragment). The following symbols are shaded grey: "man with hand in the air" and "incumbent bull". The imaginary line that the man with his hand in the air is standing on runs right across the sign of Gemini – he is standing in Gemini, that is. Based on the drawing from [544], Volume 6, page 730.

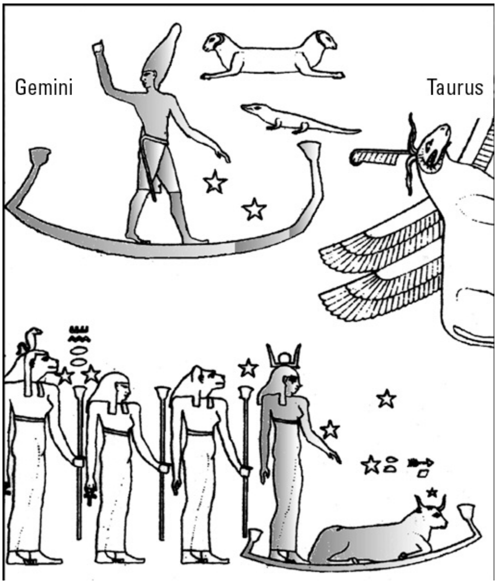


Fig. 14.12. Fragment of the EM zodiac from the Lesser Temple of Esna. The following symbols are shaded: "man with hand in the air" and "incumbent bull (with a woman)". The woman is standing in the same boat as the bull. She appears to have fired a shot at the latter from her bow, likewise in the Round Zodiac (DR). Although we don't see any bow in the woman's hands, there is a small arrow over the head of the bull. This entire group of symbols is located in between the signs of Gemini and Taurus. The zodiacal sign directions are indicated on the right and on the left, at the top of the drawing. Based on the drawn copy from [1100], A. Vol. I, Pl. 87.

Let us reiterate that all previous research in general, and the works of N. A. Morozov in particular, allowed for different interpretations of one and the same symbol (or even entire groups of symbols) in different zodiacs. Some of the examples were cited above (see also [544], Volume 6, and [912:3]). This isn't allowed in our approach.

We shall now provide the reader with a brief account of what conclusions exactly we arrived at concerning the astronomical symbolism of the Egyptian zodiacs; explanations of the astronomical symbols can be found below.

Let us begin with the remark that in many cases we run across the same, or similar, symbols on different Egyptian zodiacs. In some cases they are duplicated very faithfully – or they can vary very slightly. Furthermore, if we are to take a closer look, it turns out that it isn't just solitary symbols that recur, but whole combinations of such symbols, as well as individual symbols that one always finds in the same fixed locations of the ecliptic – that is, we see them in one and the same constellation on all Egyptian zodiacs. Naturally, this does not refer to planetary symbols, since planetary positions on the ecliptic change constantly, moving from one zodiacal constellation to another. It is therefore obvious that we are dealing with symbols that have got nothing to do with planets, yet pertain to the astronomical paradigm, since they are affixed to a certain position amidst the stars.

The important implication is that we can thus understand the symbolism of the Egyptian zodiacs better, planetary and otherwise.

An example. Consider the following group of symbols:

1) "A rod (with a bird on top of it)", see figs. 14.8 and 14.9. In some cases the rod can have no bird on its top and two similarly-shaped rods by its sides, qv in fig. 14.10.

2) "Man with a raised arm", qv in figs. 14.9, 14.11 and 14.12. If there is a planetary staff in the other hand of this man, he shall invariably be pictured as standing in a boat.

3) "Incumbent calf (and a woman)", qv in figs. 14.9, 14.11 and 14.12. The calf is often accompanied by a woman – not always, though (see figs. 14.8, 14.9 and 14.12). Sometimes we see her shoot at the calf from a bow (fig. 14.8). On some of the zodiacs we see both of them in boats (figs. 14.9 and 14.12). They may be in the same boat or in different boats; on the Round Zodiac of Dendera it is just the calf that we see in the boat, with the woman depicted without a boat (fig. 14.8).

If we take a closer look, we shall see that on all the Egyptian zodiacs the symbols of this group would only be depicted in Gemini or in the immediate vicinity of the constellation – all or some of them. We do not come across these symbols anywhere else in the Egyptian zodiacs. They appear to be "tied" to Gemini, for some reason.

We have thus discovered a link between the constellation of Gemini and a certain group of symbols present on the Egyptian zodiac. What's the implication? Why should Gemini in particular deserve extra symbolism in Egyptian zodiacs?

The very shape of the abovementioned symbols

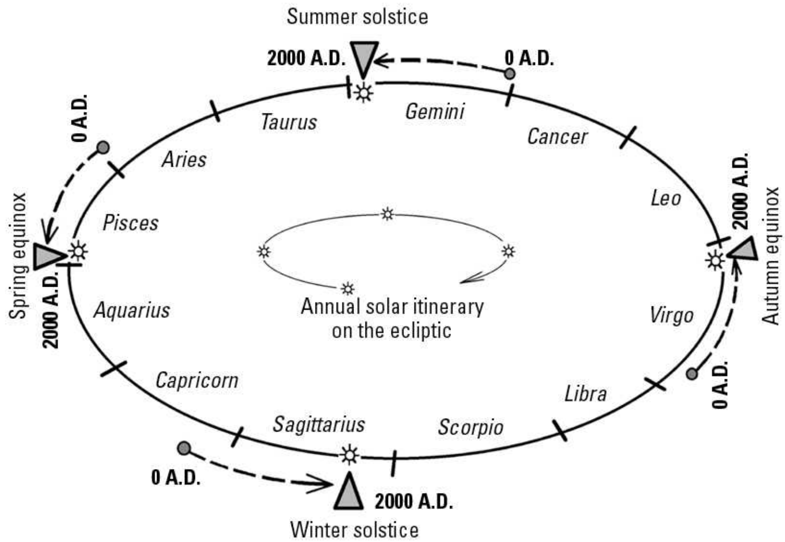


Fig. 14.13. Zodiacal circle (also known as the ecliptic) with solstice and equinox points. These points divide the ecliptic into four parts which are almost equal to one another. All of them shift across the zodiac with the speed of circa 1 degree in 70 years. They shifted by 30 degrees over 2000 years, or the length of a single zodiacal constellation (on the average). We see the shift trajectories from the beginning of the new era and until the present moment.

leads us to the answer (see figs. 14.8, 14.9, 14.10, 14.11 and 14.12. Apparently, such symbols as "bird on a rod", or a "vertical rod with two extra rods leaning against its sides" or "man with a raised arm" can refer to the peak of the solar trajectory above the horizon. Below we shall witness that the bird sign would often be used for referring to the "extra-horoscope" Sun in Egyptian zodiacs (the horoscope sign for the Sun would always be represented by a circle). Therefore, this symbol with a bird on a rod is most spectacular indeed; it leaves almost no room for doubt about the fact that it symbolises summer solstice, which would make its location in Gemini mandatory – that is where we find the solstice point, after all.

Let us remind the reader that the summer solstice point is the position of the Sun upon the ecliptic (among zodiacal constellations, in other words) for the day when its position above the horizon is the highest. This day (called the Solstice day) is the same for the entire Northern Hemisphere. Nowadays it usually falls over the 21-22 June (Gregorian calendar), when the Sun approaches the very edge of the Gemini constellation, where it borders with Taurus ([393], pages 23 and 26. See also figs. 14.13 and 14.14).

This hasn't always been the case. According to astronomy, multi-centenarian equinox precession makes the solar solstice point alter its position year after year with the rather low velocity of one degree every 72 years; this gives us a sum of roughly 30 degrees in 2000 years. The direction of the shift lies in the realm of smaller ecliptic longitude values. Other three solstice and equinox points are shifted at the same rate, qv in fig. 14.13.

Let us now recollect that the Gemini constellation occupies a roughly 30-degree arc of the Zodiacal belt, which means that the sun has always reached its solstice point in Gemini over the last 2000 years, moving from the boundary between Gemini and Cancer, where it had been reaching the solstice point before the new era, and towards the opposite end of the constellation, or the border with Taurus, where we find it at summer solstice nowadays.

We must point out that over the last 2000 years the summer solstice has always been in March, the spring equinox has taken place in June, the autumn one in September, December being the month of the winter solstice, although this is of little importance to us here (see figs. 14.13 and 13.15 above). This distribu-

The annual motion of the Sun across the modern constellations according to the Gregorian calendar

Zodiacal constellation	*Constellation symbols*	*Days when this constellation houses the Sun*
Sagittarius	♐	18 December – 19 January
Capricorn	♑	19 January – 16 February
Aquarius	♒	16 February – 12 March
Pisces	♓	12 March – 18 April
Aries	♈	18 April – 14 May
Taurus	♉	14 May – 21 June
Gemini	♊	21 June – 20 July
Cancer	♋	20 July – 11 August
Leo	♌	11 August – 17 September
Virgo	♍	17 September – 31 October
Libra	♎	31 October – 22 November
Scorpio	♏	22 November – 30 November

Between the 30 November and the 18 December the Sun remains in the constellation of Ophiuchus, which isn't included in the number of zodiacal constellations.

Fig. 14.14. The modern annual motion of the Sun across the constellations. The dates when the Sun passes the zodiacal constellations are given according to the new style, or the Gregorian calendar. In the Gregorian calendar, spring equinox takes place on 20-21 March, summer solstice – on 21-22 June, autumn equinox – on 22-23 September, and solstice – on 21-22 December. We shall come up with the same data for the epochs in the past, if we are to convert all the datings in the table into the Julian calendar system (subtracting 13 days), and account for the fact that they shift forwards in time by the speed of 1 day in 157 years in the Julian calendar (the shift is two times faster in the Gregorian calendar). In turn, the solstice and equinox days shift backwards at the rate of 1 day in 128 years in the Julian calendar (they remain more or less stable in the Gregorian), qv in [393], pages 22-26. Ancient symbols of Sagittarius, Aries and Scorpio that one sees in the second column were taken from a star chart of Albrecht Dürer found in a 1551 edition of the Almagest, qv in [METH3]:3, page 113.

tion of the equinox and solstice points became rigidly fixed in the Gregorian calendar after the reform of 1582 ([393], pages 22-23). In the Julian calendar, the equinox and solstice points gradually shift across different calendar dates over the centuries.

Since we shall often be using the "old-style" Julian calendar in the present book due to its convenience for astronomical calculations, which has differed from the consensual "new-style" Gregorian calendar ever since the October of 1582, it would be expedient for us to explain the astronomical difference between the two calendars.

There are two natural ways of estimating the length of the solar year, the simplest and most obvious one being equalling it to the time of the telluric rotation around the Sun. From the point of view of an observer located on the surface of the Earth, this is the time required for the Sun to finish its journey across the ecliptic and return to its old place among the stars. Such a "solar year" is called a "stellar year" in astronomy ([393]). The Julian ("old-style") year is roughly two times more precise in corresponding to the stellar solar year than the Gregorian ("new-style").

However, one might also suggest another way of estimating the length of a solar year, depending on the cyclic repetitions of the four seasons, which are known to be in rigid dependency on the dates of equinoxes and solstices. Therefore, each of the four seasons recurs over roughly the same period that it takes for the vernal equinox to recur, for instance. This time interval is the second version of estimating the length of the solar year and is called a "tropical year" in astronomy. The tropical solar year differs from the stellar, or the period of telluric rotation around the sun, the discrepancy between the two equalling circa 20 minutes and stemming from the fact that the climatic season recurrence period, or the tropical year, is dependent on the fluctuation period of the telluric axis to a greater extent than on the time it takes the Earth to complete its cycle around the Sun, since the advent of winter, autumn, spring or summer is primarily dependent on the bias of the telluric axis in relation to the plane of the telluric orbit, or, in other words, the height of the Sun above the horizon for a given season.

The average year length in the Julian calendar is in between the stellar and the tropical solar year. In the Gregorian calendar, the average year length is maximally close to the tropical year. As a result, the discrepancy between the average Gregorian year and the period of the Earth's cycle around the Sun exceeds that of the Julian by a factor of two.

A propos, this is where the popular opinion about the Julian calendar allegedly following a "wrong" astronomical year length comes from, one that was presumably corrected in the Gregorian calendar – all of this is blatant advertising which has got nothing in common with reality. The real length of a year in the Julian calendar is balanced well enough between the two solar years – the stellar and the tropical, differing

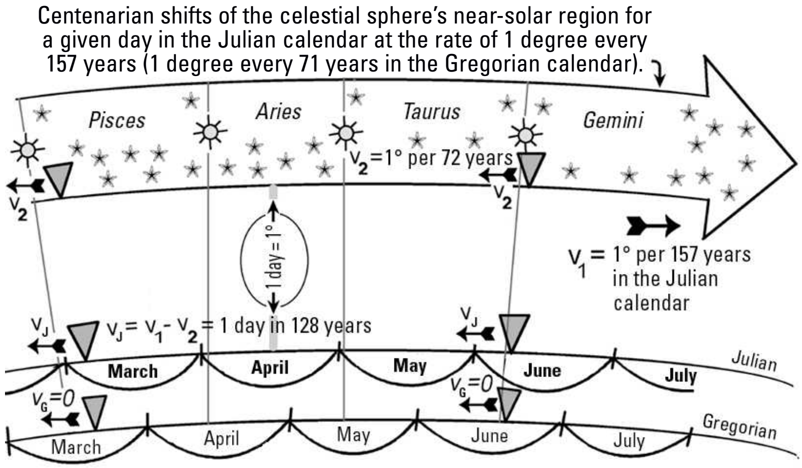


Fig. 14.15. Shifts of the spring equinox day in the Julian and Gregorian calendars as a sum of two shifts: 1) the shift of the spring equinox point on the celestial sphere, and 2) the centenarian shift of the near-solar region for one and the same calendar day. NB: In the Julian calendar, the near-solar region shifts at the average rate of 1 degree in every 157 years. This gives us some 10 degrees over 1500 years. In the Gregorian calendar, the shift is twice as fast – 1 degree in 71 years. The reason is that the duration of the average Julian year (365.25 days) is roughly in between the duration of the tropical year (365.2421988 days, qv in [393], page 29) and that of the stellar year, or the time it takes the Earth to complete its cycle around the Sun (365.256360 days, qv in [393], page 29). Therefore, the average Gregorian year, which was approximated to roughly equal the tropical, proved to be a great deal further away from the stellar year than an average Julian year.

by circa 9 minutes from the former and 12 minutes from the latter. In the Gregorian calendar this average year length all but coincides with the tropical, differing from the length of the stellar year by some 20 minutes. Thus, from the astronomical point of view, these two calendars are more or less "equal in rights". However, the Julian calendar, which contains no "leaps" in its dates, is more convenient for calculations. As for the real reasons for replacing the "old" style with the "new", it has to be said that they were rather distant from astronomy and indeed science in general. See [BR]:1 and [BR]:2 for details; also the second volume of ***Russia and Rome,*** as well as CHRON6.

Let us explain that the primary inconvenience of the Gregorian calendar (the "new style") for backwards calculations lies in the fact that it contains a 10-day leap in 1582; also, the length of a century in the Gregorian calendar is measured by a fractional number of days, unlike the Julian. This complicates calculations as well. Since the Julian calendar had officially remained the civil calendar in Russia up until 1917, we do not occupy ourselves with converting the calculated Julian dates into the "new style", even for the epochs postdating 1582 A.D. The readers are capable of doing this independently, should they so desire. Thus, all the calculated dates that we cite in this book are given according to the Julian calendar; this observation is only valid for dates beginning with 1582 A.D.

The correlation between the equinox and solstice points on the celestial sphere and the corresponding dates in the calendar, as well as centenarian shifts of the near-solar part of the star chart in the Julian and Gregorian calendars can be seen in fig. 14.15. In this illustration one sees the vernal equinox point and the summer solstice point; the other two are tied to them rigidly and shift in the exact same manner; in particular, one can calculate the fact that the summer equinox point has remained in Gemini for the last 2.000 years using figs. 14.14 and 14.15.

Let us return to Gemini in Egyptian zodiacs. We have seen that this constellation contains the summer solstice point, which is apparently also represented in Gemini as the abovementioned group of symbols that one encounters in Egyptian zodiacs, and quite clearly and unmistakably so.

Another example. On the EB zodiac from the

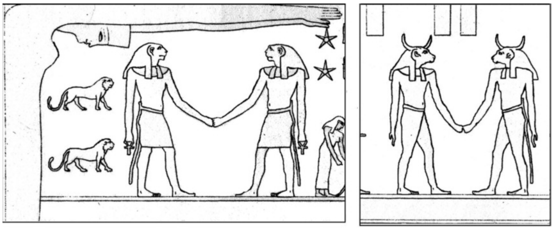


Fig. 14.16. The EB zodiac (from the ceiling of the Greater Temple of Esna). We see two very similar symbols of "meeting and handshake". In the EB zodiac we find them in the opposite points of the ecliptic, and obviously serve to mark the points of spring and autumn equinox. Namely, the left sign is located between the symbols of Leo and Virgo, while the right one is between Pisces and Aries. For the last two millennia the equinox points have remained in the respective constellations of Virgo and Pisces. On equinox days day becomes equal to night in duration, as though it were "meeting" the latter. This is precisely what the "meeting and handshake" symbol means in the EB zodiac. Fragments of a drawn copy from [1100], A. Vol. I, Pl. 79.

Greater Temple of Esna we can see two all but identical signs among all the other symbols. Each of them represents a pair of human figures with animal snouts instead of faces standing in front of each other and shaking hands – a meeting of sorts, qv in fig. 14.16. What exactly could this mean? In order to understand this better, let us study the exact location where these two "meeting signs" or "handshake signs" are encountered on the EB zodiac. It turns out that one of them is located between the signs of Virgo and Leo, and the other – in between Pisces and Aquarius, which makes them occupy the opposing ends of the ecliptic, since the constellations of Pisces and Virgo oppose each other on the celestial sphere.

What could the "meeting" and "handshake" possibly refer to in these points? The answer is a simple and obvious one. This is precisely where we encounter the vernal and autumnal equinox points. When the Sun passes through them on its annual stellar itinerary, the length of daytime and night-time become equal, or "meet", and subsequently "part", their respective duration becoming different once again. Such "meetings" of day and night take place exactly twice a year – once during the spring equinox when the Sun is in Pisces (we are referring to the last two millennia). On the EB zodiac from Esna this event is marked by the sign of "meeting and handshake" which is duplicated in Virgo for the autumn equinox.

This is the order in which the abovementioned equinox points are represented in the calendar that we're accustomed to – one that begins with January; it is also valid for a calendar beginning in March. However, the year began from September in the Egyptian zodiacs; therefore, the autumn equinox shall precede the vernal one upon them.

It is thus plainly visible that, apart from the date that the primary horoscope was dedicated to, it would also contain the date of the summer solstice, for instance, as well as the two equinoxes. Could it be that one can find the winter solstice in those zodiacs as well? It has been in Sagittarius for the last two thousand years, qv in fig. 14.13. In other words, the sun is passing through the constellation of Sagittarius when it rises above the horizon the lowest. Let us regard the very same EB Zodiac of Esna. What do we see? The Sagittarius constellation is inverted, with his head directed downwards, qv in fig. 14.17. All other constellations one finds on the zodiac are presented in the normal manner, Sagittarius being the only exception – one can therefore point out to the sun "hanging upside down" when it reaches its lowest peaking rate in Sagittarius.

As we shall see below, it wasn't necessary to invert the sign of Sagittarius on the EB zodiac, since this sign already represents the characteristics of a specially emphasised solar position, which can only be the point of the winter solstice in Sagittarius. One way of emphasising such points employed by the Egyptian zodiacs is the specific extra symbolism referring to the Sun and the planets closest thereto. We shall discuss this in detail below; for the meantime, let us merely point out that the compiler of the EB zodiac inverted the sign of Sagittarius in order to emphasize the presence of the winter solstice point there once again.

One therefore gets the suspicion that all four points of the solar circle were represented on Egyptian zodiacs for some reason – both solstices and equinoxes. Is this the case indeed? If the answer is in the positive, one shall have no more doubts about the fact that the abovementioned group of symbols that "accompanies" Gemini, for instance, really refers to the summer solstice, as well as the existence of a special set of symbols for each of these four points.

We have conducted a meticulous study of every Egyptian zodiac that we'd had at our disposal from this particular viewpoint and confirmed the fact that they really appear to contain special indications used for solstices and equinoxes (we shall discuss the actual symbols below).

The general picture that one comes up with is as follows. Nearly all of the old Egyptian zodiacs (the more detailed ones, at the very least) contain references to the four primary points of the solar cycle, which, as we know from astronomy, separate the zodiacal belt (or the ecliptic) into four parts that are all but equal to one another (see fig. 14.13). Over the last 1.500-2.000 years these points have been located in the following constellations:

Spring equinox – Pisces;
Summer solstice – Gemini;
Autumn equinox – Virgo;
Winter solstice – Sagittarius ([393], pages 22-26).

From the point of view of astronomical dating it is significant that these four points weren't marked on Egyptian zodiacs randomly, but rather were given additional planetary symbols – namely, those representing the planets that were near the Sun that day. Laws of astronomy make Venus and Mercury invariably present in the list of such planets, since they never draw too far away from the Sun. However, in certain list other planets' chance proximity to the sun also became reflected in these lists, which made them rather rich, constituting a horoscope – never a full one, though. Still, in addition to the primary full horoscope, it can affect the dating substantially.

Let us not that the most useful planet in such "partial" horoscopes is usually Mars due to the fact that its ecliptic speed is high enough, and his position in relation to the equinox or solstice point can be drastically different from that in the primary horoscope, which doubles the Martian input in the source data used for astronomical dating.

One might wonder about the means the Egyptian astronomers and artists used in order to avoid confusion between the planets of the primary horoscope, and the symbols of the very same planets given for the solstice/equinox points? We shall provide an answer to this question below, as well as several actual examples of how it was done. The only thing we must point out so far is that the compilers of the Egyptian zodiacs were indeed very meticulous about distinguishing between the symbols used for the primary and secondary horoscopes, making certain nothing would affect the main date ciphered in the zodiac.

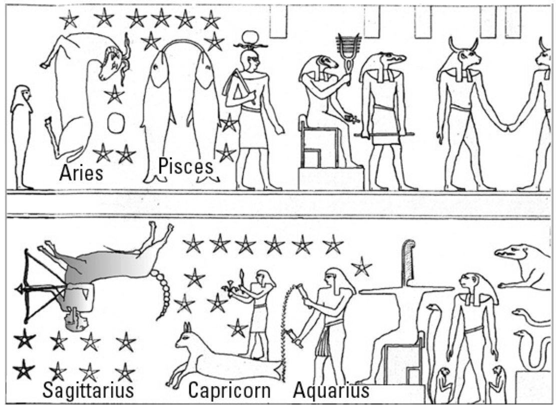


Fig. 14.17. Fragment of the EB zodiac from the Greater Temple of Esna. The constellation of Sagittarius is drawn inverted in order to signify that the Sun reaches its lowest zenith in Sagittarius, on the day of winter solstice. We find it in the lowest possible position – "hanging upside down", as it were. Based on the drawn copy from [1100], A. Vol. I, Pl. 79.

The reader might also ask why none of this had been noticed earlier – by N. A. Morozov, for instance? The main reason for this must be that it was only the advent of computers that gave us a real opportunity to calculate horoscope for many possible versions of deciphering a zodiac. It is extremely hard to understand these symbols contemplatively.

It is also possible that N. A. Morozov simply lacked the time for a more profound understanding of the Egyptian zodiacs and their astronomical symbolism. He may have been set back by his erroneous chronology and the resulting predisposition to date the Egyptian zodiacs to the epoch of the VI-XI century A.D., leaving later epoch out of consideration, while they contain the veracious datings. As for the research conducted by the Egyptologists, we already explained above that they realised the resultant dates fail to confirm Scaligerian chronology of Egypt and may only refute it, and stopped showing any interest for independent astronomical dating of the Egyptian zodiacs, as well as serious analysis of their astronomical symbolism.

Fig. 14.18. The Round Zodiac of Dendera (DR). The tablet in Pisces that serves as a spring equinox symbol. Drawn copy from [1062], pages 9 and 71 (a fragment).

One must however notice that certain individual elements of secondary horoscopes would occasionally come into Morozov's sight, yet he would always fail to realize their importance; the general picture in this area remained vague for him as a result. Basically, Morozov made a serious interpretation error here, which eventually led him away from understanding a significant part of the astronomical symbols used in Egyptian zodiacs.

Thus, for instance, N. A. Morozov is perfectly right no pay attention to the spring equinox symbol in Pisces on the Round Zodiac of Dendera. However, he refrained from any further steps in this direction for some reason, without elaborating on his observation. He merely mentions the vernal equinox sign to point out the discrepancy between the Round Zodiac and the early A.D. epoch insisted upon by the Egyptologists. Let us explain that due to precession vernal equinox only shifted to Pisces in the II century A.D. and had remained in Aries prior to that – ergo, a pre-II century dating contradicts the indication given by the Round Zodiac that the spring equinox is in Pisces. Morozov makes the following justified remark in this respect: "there is a sign between the two fishes on the Piscean symbol indicating that the spring equinox had been in that sign already" ([544], Volume 6, page 658. See fig. 14.18).

We see that the actual sign of the vernal equinox as used on the Round Zodiac was discovered by Morozov correctly. Why, then, does he explain another perfectly similar symbol found on the very same zodiac in a perfectly different manner? It is obvious that it should stand for the other equinox – autumnal, located in Virgo.

Morozov was obviously confused by the fact that the other symbol is at a certain distance from Virgo on the Round Zodiac and serves as a pedestal for the figure of Leo, qv in fig. 14.19. However, it is not the zodiacal figure of Leo. We see a different sign used for that zodiacal constellation, as the illustration demonstrates. The figure of Leo resting upon the equinox

Fig. 14.19. The Round Zodiac of Dendera (DR). The autumn equinox tablet underneath the front paws of the leonine figure (second on the left in the highlighted "group of Virgo". Virgo itself is represented by the figure of a woman holding an ear of wheat in her hand. The zodiacal constellation symbols are shaded grey. Based on the drawn copy from [1062], pages 9 and 71.

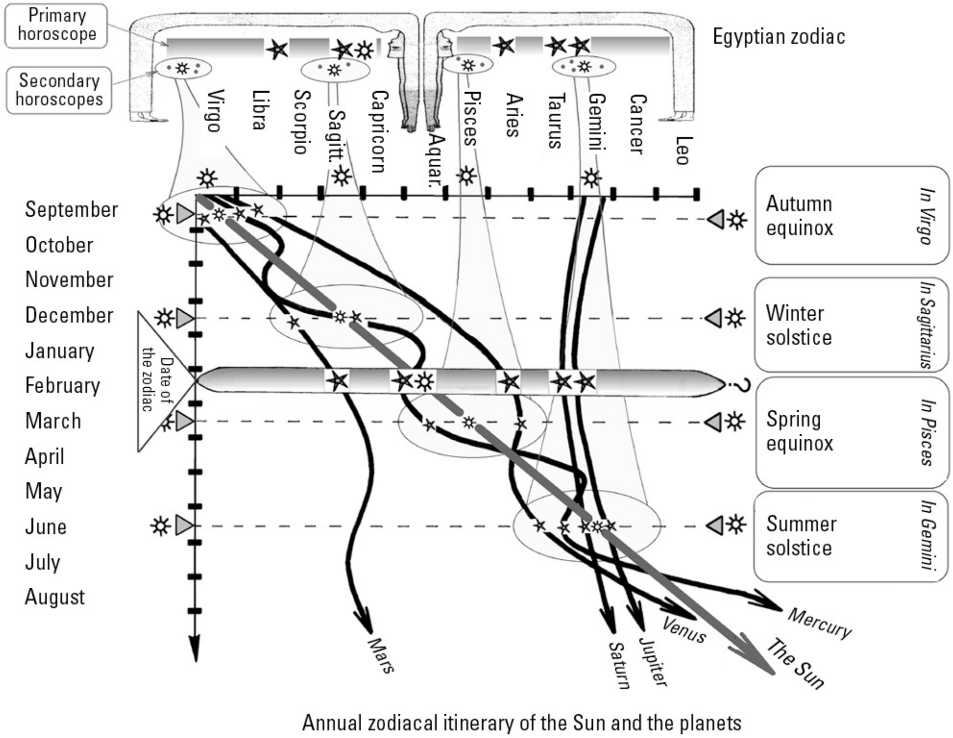


Fig. 14.20. Astronomical meaning of the Egyptian zodiac that serves as both of the following: 1) A description of planetary positions, including those of the Sun and the Moon, for the date of the zodiac. This is the primary horoscope of an Egyptian zodiac. 2) A brief description of the planets closest to the Sun on the days of the four primary solar cycle points. The latter represent the secondary horoscopes of an Egyptian zodiac. The Moon is omitted in order to keep from overcomplicating the drawing.

sign is located outside the belt of zodiacal constellations, as it is easy to see – the zodiacal belt is marked grey in fig. 14.19.

One way or another, Morozov gave the second equinox sign from the Round zodiac a wrong explanation, suggesting it to stand for a certain "road-mark with an inscription (referring to crossing the equator)" ([544], Volume 6, page 652).

Below we shall demonstrate that the symbol itself, as well as the "extra-Zodiacal Leo" resting upon it as seen on the Round Zodiac are related to the constellation of Virgo, whose sign in the zodiacal ring is located near the group of figures that includes this Leo in particular, as one can clearly see in fig. 14.19 where this entire group is specially marked. One sees that it locates exactly underneath Virgo; the symbol that the lion rests upon is part of this group and also pertains to the constellation of Virgo.

Furthermore, the entire symbolic "procession" that we find on the Round Zodiac that includes Leo resting on the equinox symbol turns out to be a secondary autumn equinox horoscope, as we shall demonstrate above – not the "retinue of a comet", according to Morozov's false assumption ([544], Volume 6, page 652). This secondary horoscope isn't hard to decipher, qv below; it is in direct relation to the astronomical dating of the Round Zodiac.

Let us sum up. It turns out that the astronomical content of the Egyptian zodiacs isn't limited to a single horoscope, or the planetary positions for the day of the "primary dating". Nearly every Egyptian zodiac contains additional astronomical information of some sort; in particular, some of them contain brief astronomical descriptions of the solstice and equinox days of the year that the main date of the zodiac falls upon. We shall be referring to them as to sec-

ondary horoscopes of the equinox and solstice points.

For example, the "secondary horoscope of summer solstice" gives us the positions of planets that were close to the Sun on the day of summer solstice, usually the planets that ended up in the same constellation as the summer solstice point or nearby, that is, in Gemini and in the neighbouring constellations of Taurus and Cancer. Apart from that, Egyptian zodiacs contain other additional astronomical information that we shall be mentioning below.

In other words, it turns out that, in general, an Egyptian zodiac is an astronomical description of the entire year that contains the main date coded in the zodiac. This date's horoscope, which we shall refer to as a given zodiac's main horoscope, is the most important part of the zodiac, but not the only one.

3. AN EGYPTIAN ZODIAC AS A DESCRIPTION OF THE ENTIRE CALENDAR YEAR THAT CONTAINS THE MAIN HOROSCOPE'S DATE

The construction of an Egyptian zodiac as that of a calendar year's astronomical description is represented as a diagram in fig. 14.20. We see how the planets follow the Sun along the belt of the zodiacal constellations, with a certain year taken as an example. It doesn't matter which year we take exactly; the planetary motion might differ, but the qualitative character of the general picture shall remain the same. Obviously, the motions in questions are referred to as seen from the Earth. To the left of the diagram, in fig. 14.20, one sees an Egyptian zodiac. As we can see from the drawing, it contains several planetary disposition for a given year – a full one and up to four partial ones, namely:

1) The disposition of all the planets, the Sun and the Moon for a given day – the zodiac date. This is the main horoscope of an Egyptian zodiac.

2) Brief descriptions of the positions occupied by the Sun and the planets in its immediate vicinity for the solstice and equinox dates. These are the partial horoscopes of an Egyptian zodiac.

Also, the Egyptian calendar year began in September, with the Sun passing the constellations of Leo and Virgo ([544], Volume 6, page 641).

4. UNLIKE PREVIOUS RESEARCHERS, WHO STOPPED AT A SINGLE INTERPRETATION VERSION THEY DEEMED BEST, WE CONSIDER EVERY POSSIBLE DECIPHERMENT OPTION FOR THE EGYPTIAN ZODIACS

The secondary horoscope symbols that we have discovered drastically change the situation with the astronomical dating of the Egyptian zodiacs. The quantity of dating criteria becomes sufficient for the dating of a zodiac in a given interpretation as well as validating the correctness of the interpretation itself. This became a possibility due to the fact that the abundance of astronomical data contained in secondary horoscope eliminates the possibility of a random solution. That is to say, a stellar configuration described in a horoscope is highly unlikely to have been generated randomly - even if we are to search for such dispositions on the interval of several millennia. Thus, an incorrect interpretation will make it impossible to find a solution in the historical interval – for the zodiacs whose astronomical content is sufficient, that is.

It has to be said that all four secondary horoscopes of a given Egyptian zodiac don't need to be really detailed, and this is usually the case indeed. Even in case of the large temple zodiacs of the "ancient" Egypt which usually tend to contain a large amount of different figures and signs, some of the secondary horoscopes prove too abstract and give no tangible results – for instance, they can be rendered useless by the fact that too few planets were near the Sun on a given day.

However, even one or two secondary horoscopes with enough detail suffice to exclude the extraneous astronomical solutions, even if we are to seek them for all possible interpretations of the main horoscope. Wrong interpretations shall be eliminated automatically as having no solutions which would satisfy to the full set of a zodiac's astronomical criteria. To rephrase what we have already been saying above, calculations render misinterpretation impossible.

We shall describe this procedure in detail below, using all the Egyptian zodiacs known to us as an example. All we need to emphasise herein is the fact that we finally have the opportunity of using all pos-

sible interpretations of a given zodiac for a given astronomical dating, including the erroneous versions, since the calculations itself tell us which of the interpretations is correct, if any. Should there be none, we won't come up with any exact solutions; that will leave us with the two possibilities, the first one being that the interpretation hadn't been found and needs to be searched for, and the second that the zodiac in question is of a figmental nature.

What we must point out immediately is the fact that not a single ancient Egyptian zodiac proved a fantasy creation from the point of view of astronomy. All of them are real astronomical texts, and complex ones as that. Creating them as a result of fantasising is very much like writing a novel pressing a typewriter's keys in a random manner.

Thus, it turns out that most Egyptian zodiacs contain enough "astronomical hieroglyphs" to secure a single astronomical solution for them, as well as validating the interpretation of these "hieroglyphs" by calculations and not expostulations, often of a very ambiguous nature.

Above we already mentioned that all the previous researchers involved in deciphering and dating the zodiacs from Egypt invariably failed to pay attention to either the secondary horoscopes or the solstice/equinox symbols present there. These symbols were discussed, but their real meaning remained beyond comprehension. Usually, these symbols were regarded as bearing no relation to astronomy whatsoever.

As it becomes clear to us nowadays, this is exactly why the datings of the Egyptian zodiacs suggested previously would often contain discrepancies. The reason for this is the incomplete decipherment of the Egyptian zodiacs and their astronomical content, which made it impossible to separate the real dating from extraneous ones, or random solutions one invariably encounters in calculations when there isn't enough data for a single unequivocal answer.

Let us point out that earlier datings of the ancient Egyptian zodiacs have been altered as a result of our research for the most part; their overwhelming majority turned out to be late mediaeval. Previous datings, mediaeval ones as well, needed to be corrected due to their inability to satisfy to the set of astronomical criteria applicable to an ancient Egyptian zodiac. Some of the corrections make the datings more recent, others – less so; however, most of the final dates ended up in the epoch of the XI-XIX century A.D.

CHAPTER 15

The symbolism of the Egyptian zodiacs

A new and more complete interpretation

1. CONSTELLATION SYMBOLS

In general, constellation figures one finds in the Egyptian zodiacs resemble the pictures of the very same constellations in old European astronomical tractates to a large extent.

All of the twelve zodiacal constellations in their "ancient" Egyptian rendition can usually be recognized without much effort and, fortunately, require no decipherment.

Nevertheless, we have discovered that Egyptian zodiacs possessed some distinctive characteristics of the constellation figures that we don't encounter in European drawings, and they haven't apparently been noticed up to now; however, they are important for the general interpretation of the zodiacs.

We are referring to the fact that the constellation figures in Egyptian zodiacs would often be united with the planetary figures, forming a complex "astronomical hieroglyph" of sorts.

We shall discuss these in more detail below, in the section that deals with the symbolism of secondary horoscopes.

In the present section we shall merely consider the Egyptian constellation symbols as such.

And so, let us go through all the zodiacal constellations and list their representations as found in Egyptian zodiacs.

1.1. Aries

Let us begin with the Aries constellation. In fig. 15.1 one sees the drawings of this constellation taken from various Egyptian zodiacs, and one from the European star chart by Dürer is shown in fig. 15.2 for comparison. Nowadays it is presumed that Dürer drew the chart in 1515 ([90], page 8). Whether or not it is true is of no importance to us at the moment; the only thing that matters is that this is a late mediaeval astronomical drawing from the XVI-XVIII Western Europe.

In fig. 15.1 one sees perfectly well that all of these "ancient" Egyptian drawings of the Aries constellations are drawn in the exact same manner as Dürer's drawing, notwithstanding the fact that in Scaligerian chronology they are separated by a monstrous gap of fifteen hundred years, which, however, didn't stop the "ancient" Egyptians from drawing the constellation of Aries in the exact same way as it was done in mediaeval Europe. This is a result of the erroneous Scaligerian chronology. Once we correct it, everything becomes clear. It turns out that the Egyptian zodiacs weren't created in deep antiquity, as the Sca-

ligerian version of history is telling us, but rather in the Middle Ages.

Let us remind the reader that, according to our reconstruction ([REC]), the development of astronomy in Egypt and Europe took place around the same time, in the atmosphere of constant interaction between various parts of the Great = Mongolian Empire – Europe and Egypt in particular. It was only after the decline and dissolution of the Great Empire that the ties between Egypt and Europe got severed for some 200 years, which only changed after the advent of the Napoleonic troops in the late XVIII – early XIX century.

We shall now return to the drawings of the constellations. Above we witnessed that the constellation of Aries looks just the same in the Egyptian zodiacs as it does in most of the European drawings from the Middle Ages. This appears to be true for most other zodiacal constellations as well.

And now, onwards along the ecliptic. We shall go through each of the 12 zodiacal constellations, comparing the way they're drawn in the "ancient" Egyptian zodiacs to the drawings of the mediaeval Europeans.

1.2. Taurus

The constellation that follows Aries on the ecliptic is the Taurus. In fig. 15.3 we see drawings of the Taurus constellation taken from Egyptian zodiacs and the mediaeval star chart by Albrecht Dürer. In each case the Egyptian drawings are very explicit about the fact that the figure in question stands for Taurus, and not any other animal figure, qv in fig. 15.3.

A propos, we should pay attention to the fact that every Egyptian drawing of Taurus has got the same shape of horns, qv in fig. 15.3. They all look like crescents, whereas the horns of Aries look drastically different, their shape being of an undulant shape, qv in fig. 15.1. It has to be pointed out that one often sees horned figures in Egyptian zodiacs – it is most likely that the shape of their horns wasn't chosen randomly, but rather carried a definite meaning. One encounters three kinds of horns in the Egyptian zodiacs – undulated, as is the case with Aries, crescent-like (Taurus), and omega-shaped, with the tips facing outwards.

If we are to consider planets, Egyptian artists would usually draw Saturn and Jupiter with horns; Saturn would usually have crescent-shaped horns, like Taurus, whereas Jupiter's horns are undulated, like those of Aries. See the section on the planetary symbolism in Egyptian zodiacs below.

1.3 Gemini

The next constellation is that of Gemini. The drawings of the constellation as seen in the Egyptian zodiacs and on Dürer's star chart can be seen in fig. 15.4. In fig. 15.5 one can also see the photograph of the Gemini drawing from the Long Zodiac of Dendera. According to the photograph, what we see in the Napoleonic album ([1100]) is a mirror reflection of the figure (however, it is possible that the image is re-

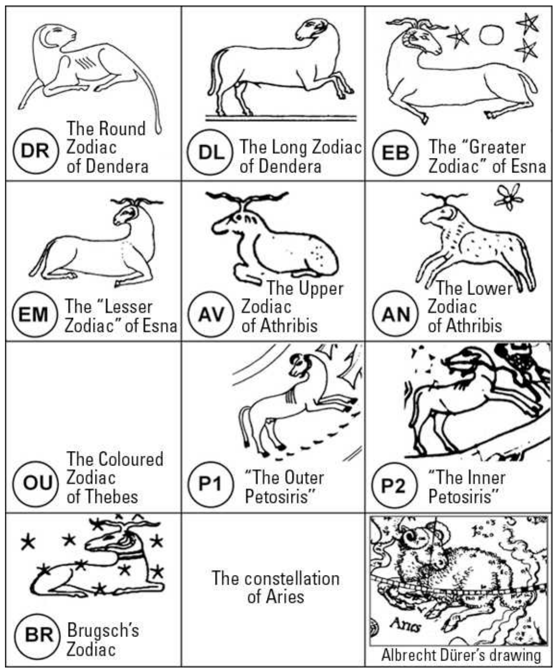


Fig. 15.1. Symbols of Aries from different Egyptian zodiacs. In the "Coloured Zodiac" from Thebes we find no such constellation, hence the blank cell. We cite a drawing of Aries from a star chart by Albrecht Dürer on the right for comparison ([90], page 8) – that is to say, a European drawing dating from the epoch of the XVI-XVIII century. One sees all of the "ancient" Egyptian symbols to be perfectly similar to the European drawing. The fragments used herein were taken from [1100], [1291], [1062], [90] and [544], Volume 6.

Fig. 15.2. Star chart of the Northern Hemisphere. Ancient engraving. This chart is presumed to have been drawn by Albrecht Dürer in 1515. Regardless of whether or not the dating is correct, we can say that what we see in front of us is a Western European astronomical drawing dating from the XVI-XVIII century. The astronomical symbols used in Europe back in the day are all represented very well in the zodiac – it is very easy to get an idea of how one drew the figures of zodiacal constellations during that epoch (alongside the ecliptic circle which we find drawn rather explicitly). Taken from [90], page 8. See also [544], Volume 4, page 204.

versed in the modern edition whence it was culled from – see [1062]).

Dürer depicts Gemini as two naked infant figures embracing, qv in fig. 15.4. Their drawings on the zodiacs of Petosiris are very similar, qv in fig. 15.4 (P1 and P2). We see the arms of the infant figures crossed as if they were embracing each other – the same as in Dürer's drawing. In all other zodiacs, excluding Brugsch's, Gemini are presented as a male/female couple either holding hands or keeping their arms crossed.

Let us make the following remark in re distinguishing between male and female figures. They are easy to tell apart in the Egyptian zodiacs since the width of steps is always smaller in case of female figures. This allows us to distinguish between them with enough certainty even when the drawings look too abstract or happen to be in a bad condition. As we shall witness below, the sex of one figure or another may be very important for the decipherment of their astronomical meaning.

And now to return to the ancient Egyptian pictures of Gemini. Pay attention to the fact that in both of the Esna zodiacs the couple depicting Gemini is accompanied by another male figure, one that holds a long stick in both hands. We must point out that the stick is most likely not to be a planetary staff, since the staves held by planetary figures have rather characteristic toppings, which isn't the case with the stick in question. We see a small lamb run in front of the figure that holds the stick, qv in fig. 15.4. We lump this figure together with the Gemini sign, although it may possibly be another symbol of the summer solstice as mentioned above. These symbols are always located near the sign of Gemini, since that is where the summer solstice point is, qv above.

Let us now explain why in many of the Egyptian zodiacs one of the Gemini figures is male and the other female. Pay attention to the following significant detail – rather often, in three cases out of nine, the head of the female figure is topped by a circle (sometimes also a snake), whereas on the head of the male figure we see a feather, qv in fig. 15.4. We shall jump ahead and explain the meaning of these symbols. What we see is a secondary summer solstice horoscope united with the drawing that depicts the constellation of Gemini. Its meaning is as follows:

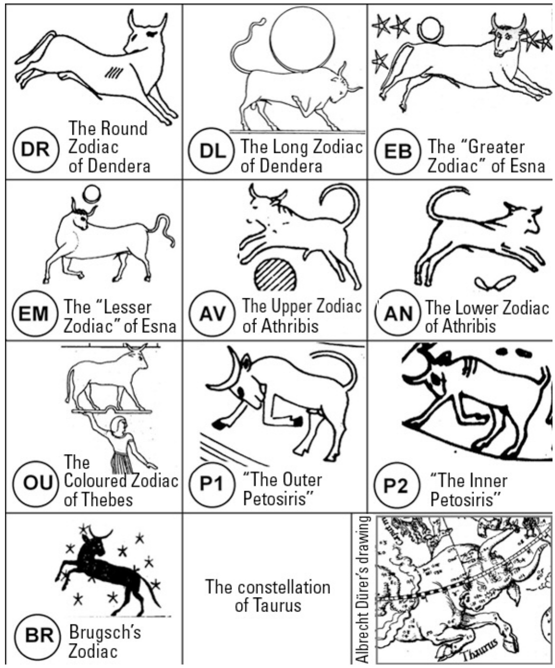


Fig. 15.3. Symbols of Taurus from different Egyptian zodiacs. A drawing of the same constellation done by Albrecht Dürer is presented on the right for comparison ([90], page 8). One sees all of the "ancient" Egyptian symbols to be perfectly similar to the European drawing. The fragments were taken from [1100], [1291], [1062], [90] and [544], Volume 6.

what we see in Gemini is the Sun and the two planets which are the closest thereto, Venus and Mercury. The secondary symbols for the Sun, Venus and Mercury are presented as a single "astronomical hieroglyph" that also depicts the constellation of Gemini. The actual Gemini figure here is nothing but a pair of figures holding hands. The feather on the head of one of the figures represents Mercury. It has to be pointed out that the figure of the "Gemini figure with a feather" is always male, which corresponds to the male gender of Mercury, whereas the other figure (the female one) stands for Venus, whose gender is female. The symbolism of Venus in Gemini is emphasized even more in the Long Zodiac of Dendera – she is drawn with a leonine head, which is a sign for Venus in the Egyptian zodiacs, as we demonstrate below. Finally, the Sun is represented by the circle on the head of Venus (in Gemini).

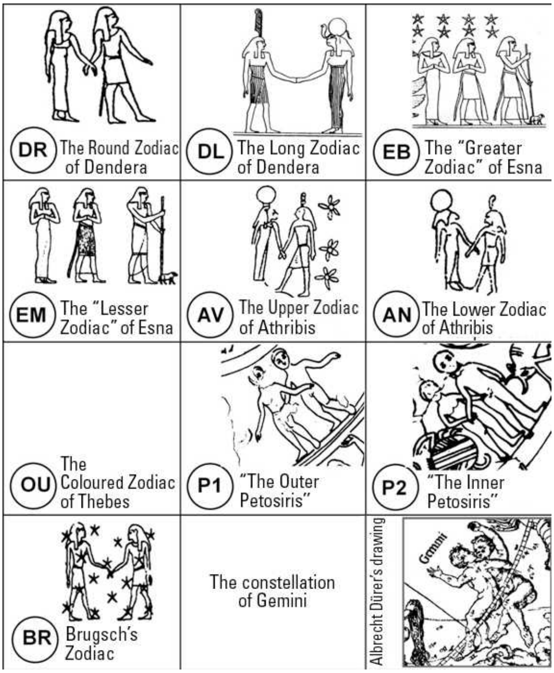


Fig. 15.4. Symbols of Gemini from different Egyptian zodiacs. We don't find this constellation in the "Coloured Zodiac" from Thebes, and the respective cell was therefore left empty. A drawing of the same constellation done by Albrecht Dürer is presented on the right for comparison ([90], page 8). One sees that all of the "ancient" Egyptian symbols resemble the European drawing. Fragments taken from [1100], [1291], [1062], [90] and [544], Volume 6.

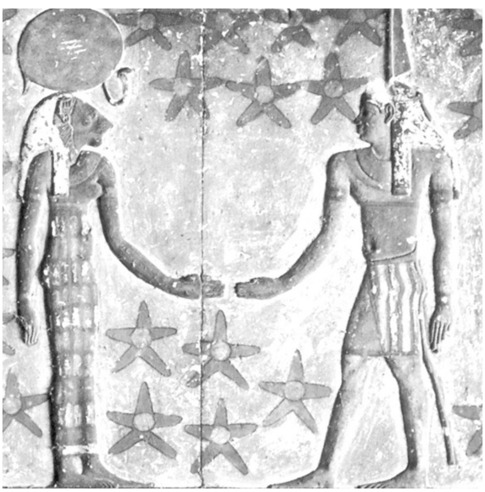


Fig. 15.5. Gemini in the Long Zodiac of Dendera (DL). Modern photograph. Taken from [1062], photograph on front cover.

What we have in front of us is a secondary horoscope of summer solstice in Gemini. In the present case it only includes Venus and Mercury, or the planets one always finds near the sun. Other planets which were accidentally close to the Sun around the summer solstice could be represented specifically, yet not included in the "astronomical hieroglyph" of Gemini.

We shall discuss the secondary horoscopes of equinox and solstice points in more detail below. For the meantime, let us just bear in mind that the couple of a man with a feather on his head and a woman with a circle on hers stands for the constellation of Gemini in Egyptian symbolism. This shall aid us greatly later on, when we shall be confronted with the problem of deciphering the Lesser Zodiac of Esna (Em), which is one of the most complex Egyptian zodiacs inasmuch as the astronomical symbolism is concerned.

Now let us consider the sign of Gemini as seen in Brugsch's zodiac (BR). Here we see the sign of Gemini drawn as two male figures holding hands, qv in fig. 15.4. The concept is virtually the same as in Dürer's drawing, the only difference being that both figures are clothed and not naked in this case. However, there are no naked figures in Brugsch's zodiac whatsoever. Even Nuit, who we usually see naked in Egyptian zodiacs, is wearing a tunic, qv in fig. 12.17.

This makes the zodiac of Brugsch somewhat different from all the other ancient Egyptian zodiacs where one usually encounters naked figures. This could result from the fact that Brugsch's zodiac is more recent than all the other ancient Egyptian zodiacs in question. The astronomical dating of Brugsch's zodiac demonstrates that it was drawn as recently as in the XIX century, qv below. It appears that by that time there weren't any naked figures left in the "ancient" Egyptian funereal zodiacs. Dürer, on the other hand, drew his constellation of Gemini a great deal earlier, in the XVI-XVII century. Incidentally, the Scaligerian dating of Dürer's lifetime might be erroneous; it is likely that he had really lived a whole century later than what is assumed today – in the XVII century and not the XVI. See Chron7, Chapter 18:8, for more details.

1.4. Cancer

Let us move on to the next constellation, which is Cancer. Different representations of the constellation

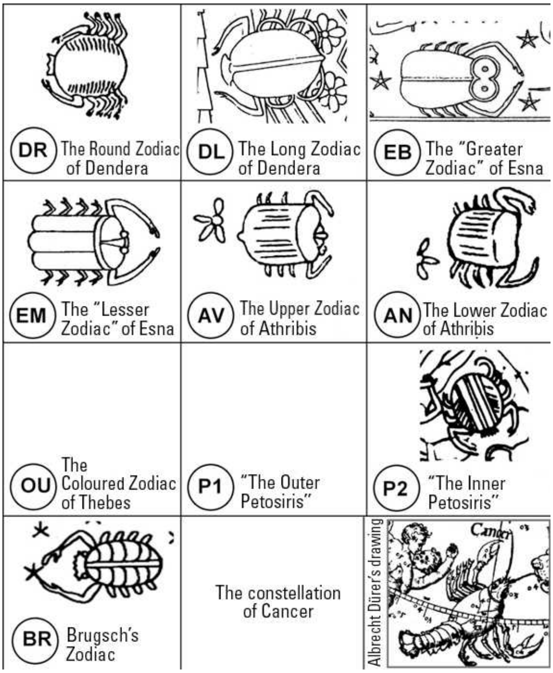


Fig. 15.6. Symbols of Cancer from different Egyptian zodiacs. We don't find this constellation in the "Coloured Zodiac" from Thebes. In the P1 zodiac (the outer chamber of the Petosiris tomb) Cancer wound up in the destroyed part of the zodiac. The respective cells were therefore left empty. A drawing of the same constellation done by Albrecht Dürer is presented on the right for comparison ([90], page 8). One sees that all of the "ancient" Egyptian symbols resemble the European drawing. Fragments taken from [1100], [1291], [1062], [90] and [544], Volume 6.

in question can be found in fig. 15.6, likewise Dürer's drawing. One sees that Dürer's rendition is a lot more realistic than that of the Egyptian artists, who made the figure resemble a bug or a crab with a pair of human hands or some such instead of claws, qv in fig. 15.6. Nevertheless, the figure of Cancer as encountered in Egyptian zodiacs is more or less uniform and easily recognizable.

By the way, the sign of Cancer isn't part of the constellation row in the Dendera zodiacs – for instance, in the Round Zodiac of Dendera all of the constellations form a circle, whereas Cancer is located sidewise, closer to the middle of the drawing, qv in figs. 15.7 and 15.8. One might thing that the Egyptian artist simply made a wrong estimation about the amount of space available, and thus had to draw Cancer in a different spot. However, this doesn't appear to be the case, since in the Long Zodiac of Dendera the sign of Cancer is outside of the zodiacal constellation sequence, and even more explicitly so, being near the knees of "Nuit the goddess", qv in fig. 15.9.

The reason for Cancer being drawn in this odd manner on the zodiacs of Dendera remains unknown to us. Apparently, the ancient Egyptian artist intended to communicate something in this manner, but it remains unclear what exactly that might be. We should mark that emphasizing Cancer in this manner is a trait that is only inherent in the Dendera zodiacs, and doesn't manifest in any other Egyptian zodiacs.

At any rate, it is clear that Cancer's being outside of the ecliptic sequence in the Round Zodiac isn't a consequence of an error or inaccuracy from the part of the Egyptian artist, as N. A. Morozov assumes in [544], Volume 6, for instance. On the contrary, one gets the impression that the astronomical symbols were introduced into Egyptian zodiacs with the utmost accuracy – however, nowadays we often find ourselves unable to comprehend the minor details of ancient Egyptian symbolism, which isn't actually a necessity for the purposes of astronomical dating.

The fact that the Egyptian zodiacs apparently neither contain errors, nor minor astronomical imperfections, is, on the contrary, very important for the decipherment and the astronomical dating of the Egyptian zodiacs. Bearing this in mind, below we shall try to find absolutely precise astronomical solutions for the Egyptian zodiacs. This approach shall prove justified, since we shall indeed arrive at precise solutions.

By the way, one used to think that Egyptian zodiacs contained artists' errors, which would periodically surface – N. A. Morozov, for one, adhered to this opinion, allowing for minor discrepancies between an Egyptian zodiac and is astronomical solution, and often resorted to such presumptions in his work ([544], Volume 6), alleging that the Egyptian artists may have been inaccurate, erring since they weren't professional astronomers, or for some other reason. Such ideas of the zodiacs would lead to an altogether different approach to the search of a given zodiac's finite astronomical solution. As a result, N. A. Morozov and a number of other authors would often stop halfway through their research, with no hope of

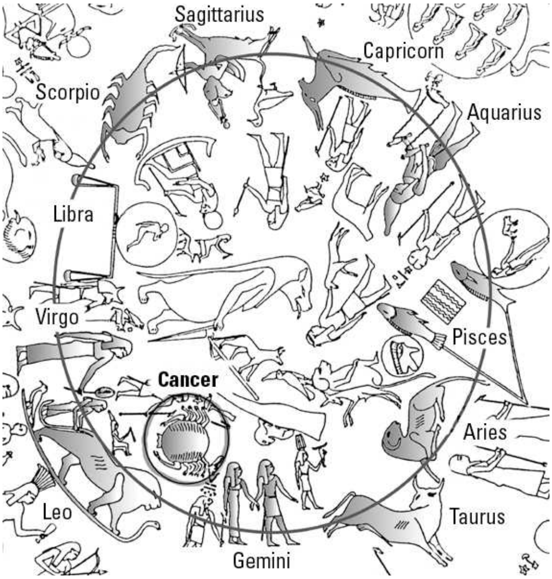


Fig. 15.7. The Round Zodiac of Dendera (DR). The signs of all twelve zodiacal constellations are shaded. All of them form a circle, with the sole exception of Cancer, whose sign is moved sideways for some reason. Based on the drawn copy from [1062], pages 9 and 71.

finding precise solutions. They could come to an "almost precise" solution and consider it the final answer, assuming there were none of higher precision and easily explaining the discrepancies between the zodiacs and the solutions in question by references to the inaccuracy of the Egyptian artists who drew these zodiacs. However, we already mentioned the fact that this is not the case with the Egyptian zodiacs, which contain no astronomical errors and allow for perfectly precise solutions. However, finding such solutions is anything but an easy task, and requires a volume of calculations too great to be performed without modern computer technology, which N. A. Morozov had no access to.

1.5. Leo

The next constellation in the Egyptian zodiacal sequence is that of Leo; its drawings as seen in Egyptian zodiacs and on Dürer's star atlas can be seen in fig. 15.10. As one can see from the drawing, Leo is easy to recognize on almost all of the Egyptian zodiacs.

Leo as drawn by the Egyptian artist has two distinctive characteristics that one has to bear in mind for the decipherment.

Firstly, Egyptian artists would often draw a female figure as a part of the constellation. The woman usually rides on Leo's tail or holds on to it, qv in fig. 15.10. This figure is usually drawn on the side of Virgo, the neighbouring constellation, and so one could initially confuse it for Virgo; however, this isn't the case with most of the Egyptian zodiacs where the constellation of Virgo is explicitly drawn separately, as a woman holding an ear of wheat. It is only in the Higher Zodiac of Athribis that the figure holding Leo's tail is that of Virgo, the tail also being the ear of wheat in her hand, qv in figs. 15.10 and 15.11 (cell AV). However, in the other zodiacs the female figure near Leo's tail does nevertheless appear to be related to the constellation of Virgo in some way.

The matter is that in the Egyptian zodiacs the respective figures of Leo and Virgo are drawn in their natural position, standing on the ecliptic line in the exact same way as they do on Earth; therefore, Leo occupies a great deal more place on the ecliptic than Virgo. Leo stands on four paws, with its body stretched horizontally parallel to the earth (the ecliptic). Thus, we see Leo occupy a substantial segment of the ecliptic, whereas Virgo stands on two feet and occupies a relatively small amount of ecliptic space.

However, if we are to turn to the real position on the star chart, we shall witness the exact opposite of this picture. Virgo occupies a great deal more space on the ecliptic than Leo, being the longest of all 12 ecliptic constellations, qv in fig. 14.14, for instance, according to which the Sun stays in Virgo for a whole 45 days, whereas it spends only 38 in Leo. This is also a large number on the average, yet it is smaller than in the case of Virgo. In other words, the constellation of Virgo takes up a 45-degree arc on the ecliptic, which is bigger than that of any other zodiacal constellation.

A propos, this is why A. Dürer depicts Virgo as laying on the ecliptic and not standing on it, since a standing human figure simply isn't wide enough to occupy as many degrees as the constellation of Virgo occupies. Egyptian artists appear to have found another way out of this predicament drawing Virgo standing in the natural manner, not really minding the fact that it occupies too narrow a space on the

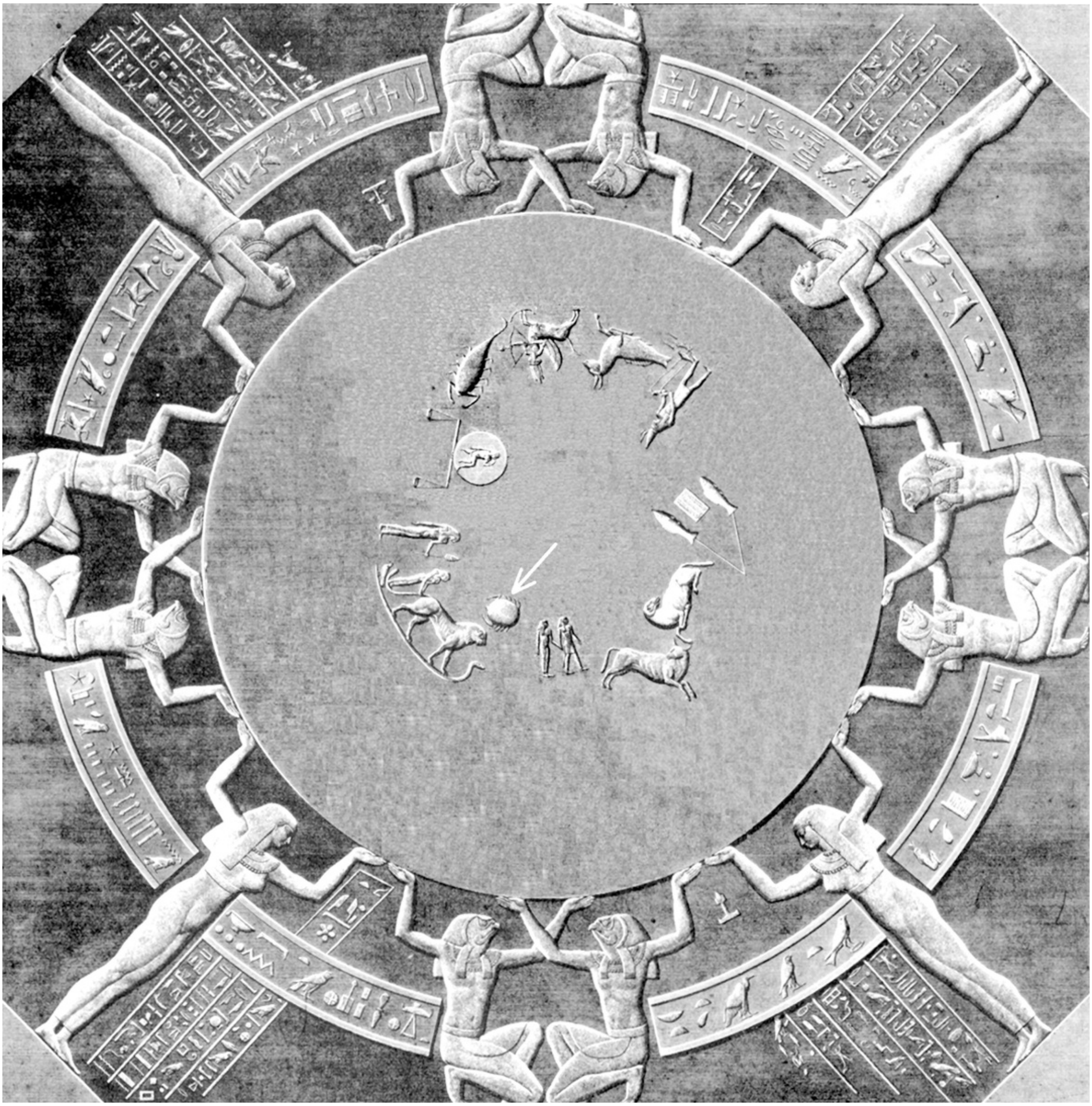


Fig. 15.8. The disposition of all twelve zodiacal symbols in the Round Zodiac of Dendera. The only symbols present in the central circles stand for constellations; the rest were edited out. One sees that all the constellation signs are meant to form a circle, Cancer being an exception. We see it sideways from the constellation procession; it is marked by an arrow in the drawing.

ecliptic. The rest of Virgo would be taken up by Leo, since a quadruped animal would be a lot easier to stretch horizontally; however, the artists would draw an additional female figure near it in order to emphasize that Leo wasn't really Leo, but rather Virgo from this side.

The second distinctive characteristic of Leo as drawn on the Egyptian zodiacs is instantly visible once we look at fig. 15.10 – in nearly every Egyptian drawing Leo appears to be standing upon a convoluted serpent figure, or has something that resembles a serpent or a crocodile under its paws. As we shall

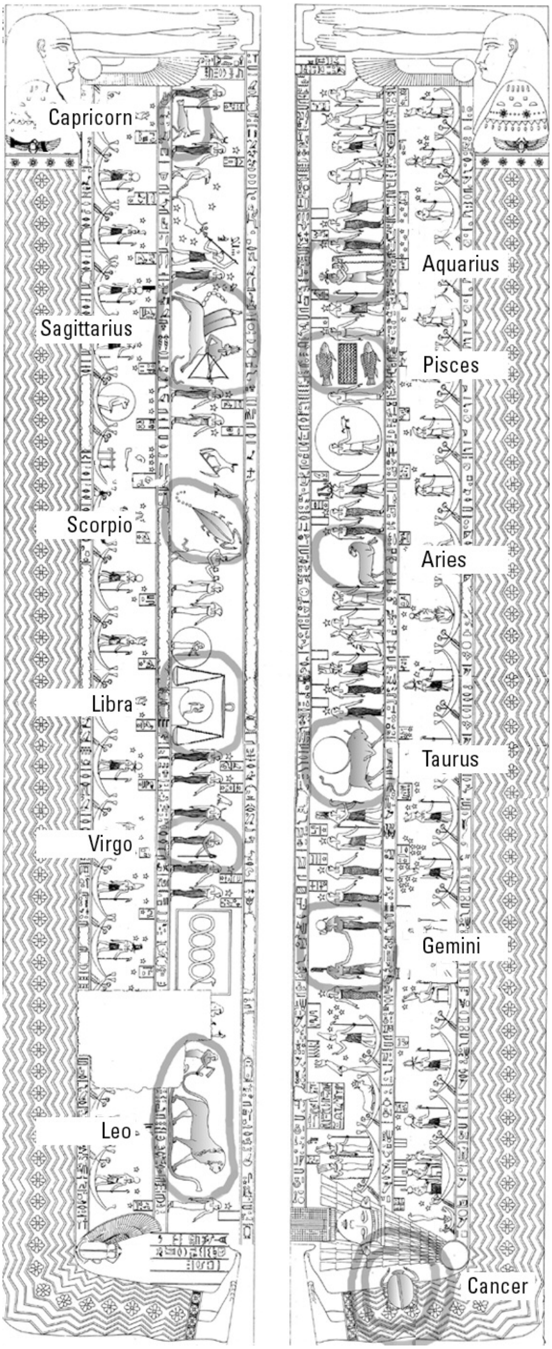


Fig. 15.9. The disposition of the twelve zodiacal symbols in the Long Zodiac of Dendera (DL). All of them are located in the primary zodiacal strip, except for Cancer. The symbol of Cancer is moved sideways, and this is emphasised in the drawing. Based on the drawn copy from [1100], A. Vol. IV, Pl. 20.

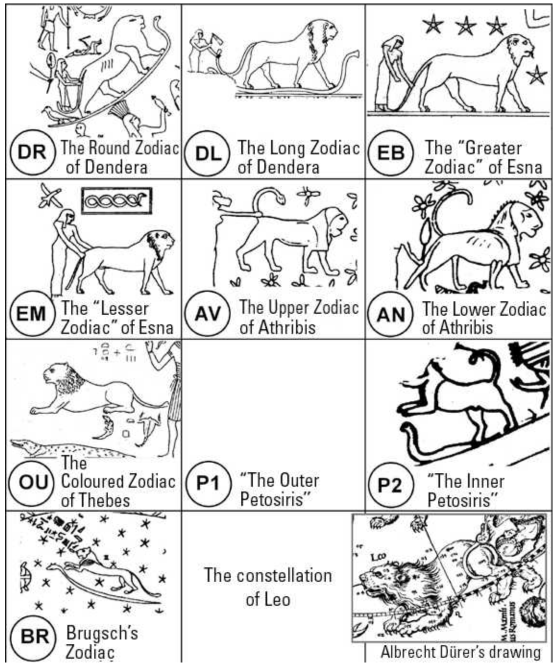


Fig. 15.10. Symbols of Leo from different Egyptian zodiacs. In the P1 zodiac (the outer chamber of the Petosiris tomb) Leo wound up in the destroyed part of the zodiac. The respective cell was therefore left empty. A drawing of the same constellation done by Albrecht Dürer is presented on the right for comparison ([90], page 8). One sees that all of the "ancient" Egyptian symbols resemble the European drawing. Fragments taken from [1100], [1291], [1062], [90] and [544], Volume 6.

explain below, a foreign object under a figure in the Egyptian zodiacs would normally mean that the figure was "misplaced", in a way, or removed from the position it would occupy, had there been nothing under its feet.

This method was often used in Egyptian zodiacs and allowed the Egyptian artists to draw astronomical events which didn't pertain to the main date of the zodiac, or "shifted in time", in a way. They could also use it for shifting one symbol or the other on the drawing if its "rightful" place was cluttered up too much – such "shifting" base objects would most often be boats or snakes.

What we witness here appears to be the same method in action. The snake under the paws of Leo most probably refers to the fact that the latter is shifted sideways from its customary place, occupying the

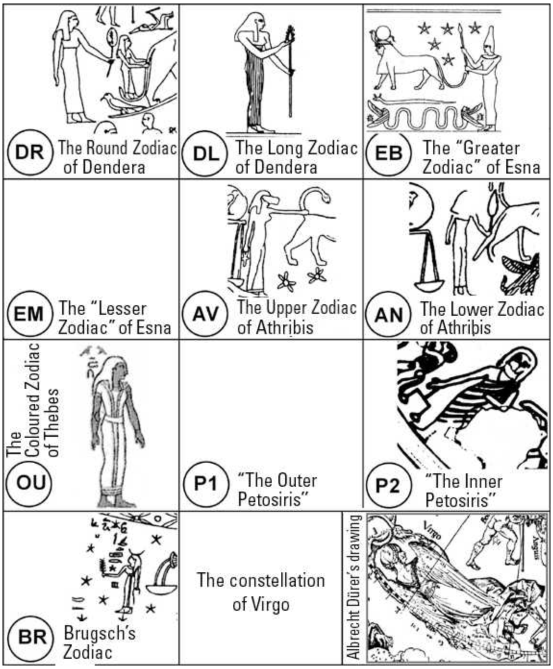


Fig. 15.11. Symbols of Leo from different Egyptian zodiacs. In the P1 zodiac (the outer chamber of the Petosiris tomb) Virgo wound up in the destroyed part of the zodiac. The respective cell was therefore left empty. A drawing of the same constellation done by Albrecht Dürer is presented on the right for comparison ([90], page 8). One sees that all of the "ancient" Egyptian symbols resemble the European drawing. Fragments taken from [1100], [1291], [1062], [90] and [544], Volume 6.

space related to the neighbouring constellation of Virgo – or, alternatively, the "shift" of Virgo's double towards the figure of Leo means that the part of Leo in question really occupies a part of Virgo's space, as mentioned above.

Apart from that, let us bear in mind that the autumn equinox point is located in Virgo – ergo, we are likely to find the corresponding symbols of a secondary horoscope nearby, qv in fig. 14.20. Such symbols would often be placed on "shifting bases"; thus, the snake under Leo could also stand for the autumn equinox point located in the vicinity of the secondary horoscope.

As a matter of fact, the actual autumn equinox point, despite being in Virgo, may have been considered "covered" by the neighbouring figure of Leo due to the Virgo's figure being "narrow" – especially bearing in mind that, as we have seen, one would often find a second Virgo on Leo's tail; thus, the figure of Leo could simultaneously "serve" the constellation of Leo and part of Virgo. Indeed, in fig. 15.11 (Em) we see that the plaque of the autumn equinox (the convoluted serpent figure in a frame) is located right over the constellation symbol for Leo, which has an "extra Virgo" holding onto its tail here, qv in fig. 15.11 (Em).

Let us also mention that N. A. Morozov had tried to explain the snake underneath Leo as a symbol used for referring to the Hydra constellation – erroneously so, as we think ([544], Volume 6, page 658). He was basing his research on the fact that the constellation of Hydra should be seen underneath Leo in the sky – however, in this case the snake in the zodiacs should also be visible next to these constellations which all border with Leo. We see none of it in the Egyptian zodiacs. The main thing, though, is that the Egyptian artists would also draw the snake underneath the figures which are located at a considerable distance from the Hydra constellations (we shall provide examples below). This is why we think Morozov must have been wrong – it is most likely that no other constellations except for the zodiacal ones can be seen anywhere in the Egyptian zodiacs; we failed to have found any such references, at any rate.

We shall conclude with the quote that N. A. Morozov makes in re Leo as drawn in the Round Zodiac of Dendera. Morozov writes the following: "The constellation of Leo is located atop that of Hydra, which remains in this position to this date; instead of Corvus, the Crow, the artist erroneously drew the Dove, or Columba" ([544], Volume 6, page 658). As one can plainly see, Morozov needed to use "bad quality" of the Round Zodiac as an excuse; however, we believe here to be no astronomical imperfections in the Round Zodiac – or indeed in any other Egyptian zodiac that we studied.

1.6. Virgo

We shall proceed to consider the constellation of Virgo, whose representations in the Egyptian zodiacs and on Dürer's star chart can be seen in fig. 15.11. All of them are easily recognizable – in most cases we see a female figure holding an ear of wheat, the only exception being the P1 zodiac from the inner chamber

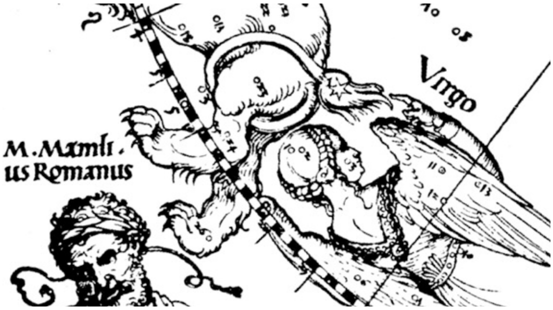


Fig. 15.12. A fragment of Dürer's star chart. In Dürer's drawing Virgo is touching the tassel on Leo's tail, as if she were supporting it, qv in fig. 15.12. We see a large star on the tassel – "Virgo's Ear of Wheat" (Spica). It is a slight modification of how Virgo is drawn in Egyptian horoscopes, where she holds an ear of wheat (which symbolises this famous star) in her hands. Taken from [544], Volume 6.

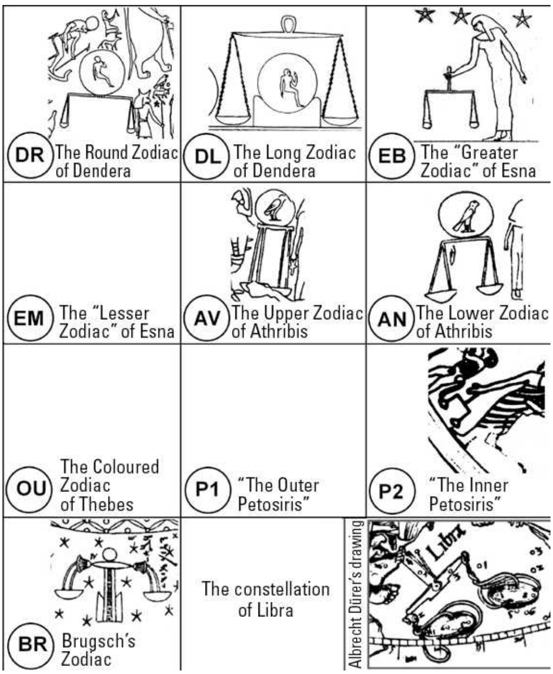


Fig. 15.13. Symbols of Libra from different Egyptian zodiacs. We don't find this constellation in the "Coloured Zodiac" from Thebes. In the P1 zodiac (the outer chamber of the Petosiris tomb) Libra wound up in the destroyed part of the zodiac. The respective cells were therefore left empty. A drawing of the same constellation done by Albrecht Dürer is presented on the right for comparison ([90], page 8). One sees that all of the "ancient" Egyptian symbols resemble the European drawing. Fragments taken from [1100], [1291], [1062], [90] and [544], Volume 6.

ceiling of the sepulchre of Petosiris, where we see Virgo without the ear of wheat and holding a balance scale instead, which is the symbol of the neighbouring Libra constellation.

As we already pointed out above, in the Higher Zodiac of Athribis we see Leo's tail in Virgo's hand instead of the ear (fig. 15.11); a similar concept is, curiously enough, embodied in Dürer's drawing where Virgo touches the tag of Leo's tail as if supporting it, qv in fig. 15.12. The tag has a star on it, qv in fig. 15.11 – Spica, or "Virgo's Ear of Wheat".

Thus, the ear of wheat symbolizes Spica, the brightest star in Virgo. This star of the first magnitude is famous in astronomy, and used to be called "Virgo's Ear or Wheat" in the Middle Ages (this is the name we find in the mediaeval European editions of the Almagest, for instance – see [704], pages 244 and 579, as well as many other European tractates on astronomy). This name must have been known quite well to the astronomers of "ancient" Egypt, too, since they used the imagery in question rather explicitly in their zodiacs, qv in fig. 15.11. Let us emphasize that this name ("Virgo's Ear of Wheat") was used by the European astronomers specifically. Egyptian astronomers would depict it in full accordance with this name; once again we encounter close ties between the "ancient" Egyptian symbolism and that of late mediaeval Europe (inasmuch as astronomy is concerned, at the very least). Coincidence between them involves even the minute details; the symbolism is virtually uniform.

1.7. Libra

The next zodiacal constellation is Libra. Its Egyptian drawings together with Dürer's can be seen in fig. 15.13. In each of them we see the easily recognizable balance scale.

Let us point out that the circle with either a human or a bird inside isn't part of the Libra drawing, as N. A. Morozov used to assume. As we discovered, it stands for the Moon in Libra, as we mentioned above, and shall discuss in more detail below.

Thus, the constellation of Libra would simply be drawn as a balance scale with two cups in Egyptian zodiacs. This is exactly how we see it drawn by A. Dürer. Additional symbol that the balance scale would occa-

sionally be decorated with in the Egyptian zodiacs would always possess an astronomical meaning of their own.

For instance, let us study the picture of Libra from the Greater Temple of Esna (the EB zodiac). What we see here isn't just a picture of a balance scale representing Libra, but rather a woman that holds a scale in her hand, qv in fig. 15.13 (EB). This female figure from the EB zodiacs bears no relation to the constellation of Libra, as we shall see below; nor does in pertain to the neighbouring constellation of Virgo, or we would see it located on the same side as the latter, whereas this figure is located on the same side as Scorpio. The actual constellation of Virgo in this zodiac is drawn elsewhere, qv in fig. 15.11. Below we shall demonstrate that the female figure with the scales stands for Venus in the secondary winter solstice horoscope from zodiac EB.

However, in zodiac P2 from the inner chamber of the sepulchre of Petosiris, we see a very similar symbol (woman holding a scale) to stand for something different; the female figure here symbolizes the constellation of Virgo, and the scale in her hand refer to the neighbouring constellation of Libra, qv in figs. 15.13 (P2) and 15.11 (P2).

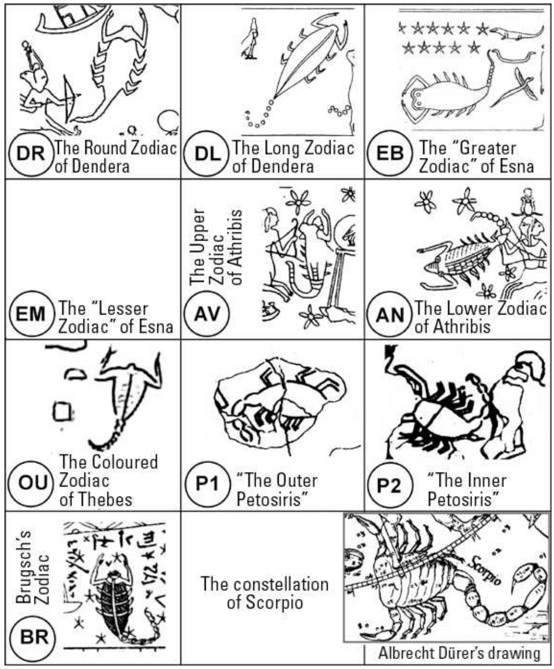


Fig. 15.14. Symbols of Scorpio from different Egyptian zodiacs. In the EM zodiac (the Lesser Temple of Esna) Scorpio wound up in the destroyed part of the zodiac. The respective cell was therefore left empty. A drawing of the same constellation done by Albrecht Dürer is presented on the right for comparison ([90], page 8). One sees that all of the "ancient" Egyptian symbols resemble the European drawing. Fragments taken from [1100], [1291], [1062], [90] and [544], Volume 6.

1.8. Scorpio

Now let us consider the constellation of Scorpio, whose Egyptian drawings, as well as the European one made by Dürer, can be seen in fig. 15.14. The sign of Scorpio is easy to recognize in all of the zodiacs, since it has an elongated body and a curved spiked tail.

In some of the cells from fig. 15.14 we see other symbols near the sign of Scorpio – let us say a few words about them in advance. In the zodiac OU to the left of Scorpio, for instance, we see a crescent to the left of Scorpio, and two hieroglyphs between them, qv in fig. 15.14 (OU). This refers to the fact that the Moon had been in Scorpio on the day whose date is ciphered in the zodiac. In other words, we see the Moon in Scorpio in the main horoscope of zodiac OU. Another example – in the zodiac EB we see a crocodile and a snake whose body assumes the shape of a boat underneath next to Scorpio, qv in fig. 15.14 (EB). The boat sign, or shift sign, indicates that what we have in front of us is most likely to be a planet whose sign doesn't pertain to the date of the primary horoscope. It is obvious that if it is part of any secondary horoscope at all, it can only be that of winter solstice, since the winter solstice point is located on this sign of Scorpio – in the neighbouring constellation of Sagittarius. As we shall learn from the dating of the EB zodiac, what we see here is Mercury in Scorpio on the day of winter solstice in 1394 A.D. (see details below, in Chapter 17 of CHRON3).

1.9. Sagittarius

The next constellation is Sagittarius. Its pictures as taken from Egyptian zodiacs and Dürer's star chart are collected in fig. 15.15. In each case Sagittarius is represented as a centaur shooting in the direction of Scorpio. Let us point out that in Egyptian drawings

the equine part of the centaur would also sport wings, qv in fig. 15.15. Dürer's drawing has a flaunting cape that resembles a pair of wings in their stead (*ibid*).

The winter equinox point has remained in Sagittarius for the last two millennia; one would therefore be correct to expect this sign to have additional symbols in Egyptian zodiacs – ones related to the secondary summer solstice horoscope, as was the case with Gemini, qv above (let us remind the reader that the sign of Gemini is represented by a complex "astronomical hieroglyph" in Egyptian zodiacs, where the actual sign of Gemini would become combined with the signs for the Sun, Venus and Mercury – that is to say, they include the signs of a minimal secondary horoscope. We see the same happen to the Egyptian drawings of Sagittarius.

Indeed, let us study them in more detail. Firstly, one has to point out that Sagittarius almost always has two faces, one of them being human and the other leonine. One sees this very well in fig. 15.15 (cells DL, EB and AV), or the Long Zodiac of Dendera, the Greater Zodiac of Esna, and the Upper Zodiac od Athribis. This is most likely to be a reference to Mercury (human face) and Venus (leonine face) in Sagittarius (or its immediate vicinity) on the day of winter solstice. The fact that Venus often has a leonine face in Egyptian drawings shall be considered in more detail below, in the planetary symbolism section. Apart from that, the actual fact that the figure has two faces might be a secondary reference to Mercury, and possibly also Venus, which were considered "two-faced" or double planets in ancient astronomy owing to the fact that they are both "inner planets" located closer to the sun than the Earth. Therefore, they always accompany the Sun on its celestial journey and can appear on its either side, disappearing behind it in between. Thus, both of them can be observed from the Earth in two phases – as a morning star at dawn, on one side of the Sun, and as an evening star at dusk on the other. Hence the ancient concept of "two-faced" planets Mercury and Venus. This applies to Mercury more, since it is closer to the sun, and the abovementioned pattern of behaviour is a great deal more manifest in its case. Mercury would most often be drawn with two faces in Egyptian zodiacs.

Owing to the above, the two faces of Sagittarius are most likely to be a reference to Venus and Mercury in the secondary winter solstice horoscope. In other words, we have another "astronomical hieroglyph" before us, as was the case with Gemini. It should also include the symbol of the Sun, since the secondary horoscope in question explicitly refers to its presence here, in the point of the winter solstice. Indeed, in most Egyptian zodiacs we see a tall hat topped by a circle on the head of Sagittarius, the circle being double in the Round Zodiac of Dendera, qv in fig. 15.15 (DR). This second circle is most likely to stand for the Sun in Sagittarius during the winter solstice (bearing in mind that in the constellation of Gemini the sun during the summer solstice is represented by a circle atop the head of a constellation figure, qv above). In the Long Zodiac of Dendera the

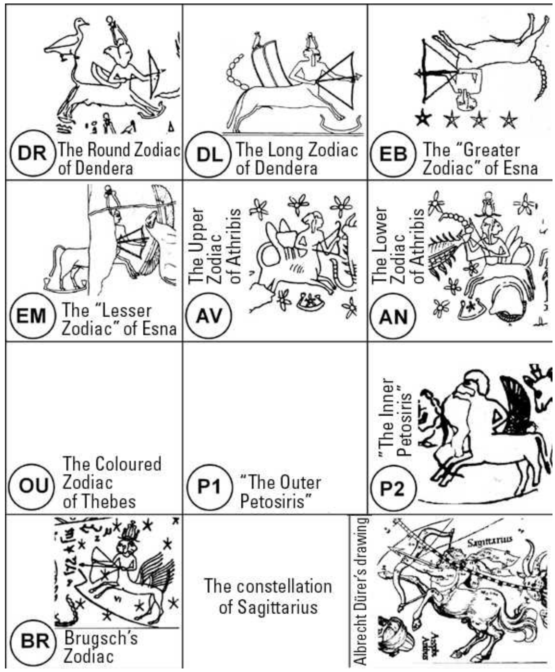


Fig. 15.15. Symbols of Sagittarius from different Egyptian zodiacs. We don't find this constellation in the "Coloured Zodiac" from Thebes. In the P1 zodiac (the outer chamber of the Petosiris tomb) Sagittarius wound up in the destroyed part of the zodiac. The respective cells were therefore left empty. A drawing of the same constellation done by Albrecht Dürer is presented on the right for comparison ([90], page 8). One sees that all of the "ancient" Egyptian symbols resemble the European drawing. Fragments taken from [1100], [1291], [1062], [90] and [544], Volume 6.

Sun in Sagittarius is represented in yet another manner – as a bird sitting on the equine part's wing, qv in fig. 15.15 (DL). See more in re the bird as a solar symbol in the Long Zodiac of Dendera and several other Egyptian zodiacs below.

Also, we see a very manifest shift, or transfer symbol manifest in Sagittarius explicitly, and this symbol is already known to us very well – the boat underneath the figure of Sagittarius. We see this boat in almost every Egyptian zodiac, qv in fig. 15.15. We see it under the front legs of the Sagittarian equine part in some cases, and under its hind part in others. As for Brugsch's zodiac, we see the entire figure of Sagittarius in a boat, for instance. This boat refers to the presence of secondary horoscope symbolism here, or planetary symbols "shifted sideways" from their position in the primary horoscope. We mean the signs of Venus and Mercury united with the Sagittarian figure. In the horoscopes of Athribis we also see a star in the boat – most probably Venus, which is much brighter than Mercury.

1.10. Capricorn

Now let us turn towards the representations of the Capricorn constellation as collected in fig. 15.16. This constellation would be drawn as a fantasy animal with the tail of a fish and the front part of a goat. The figure of Capricorn is more or less uniform in all of the horoscopes – Dürer's as well as the Egyptian ones.

Let us pay attention to the fact that in the EB zodiac (the Greater Temple of Esna) there is an extra human figure drawn as part of the usual Capricorn figure, qv in fig. 15.16 (EB). This human figure stands on the back of Capricorn holding two objects (fig. 15.17). One of them is already familiar two us, although it is really minute in this drawing – the erect pole with two slanted poles on its sides, which is a symbol of the summer solstice point present on the very same zodiac EB in Gemini, already of a larger size, qv in fig. 14.10 above. Why do we see the summer solstice symbol in the opposite part of the zodiac (Capricorn)? Apparently, the Egyptian artist tried to get across the idea that the nascent sun begins to "prepare" for the summer solstice in Capricorn, drawing it very small. This "embryo" of the solstice symbol would reach its full size in Gemini, qv above. This

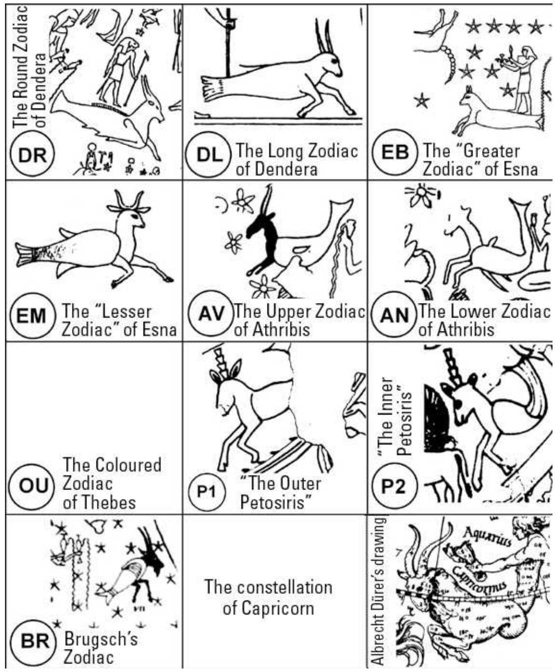


Fig. 15.16. Symbols of Capricorn from different Egyptian zodiacs. We don't find this constellation in the "Coloured Zodiac" from Thebes. The respective cell was therefore left empty. A drawing of the same constellation done by Albrecht Dürer is presented on the right for comparison ([90], page 8). One sees that all of the "ancient" Egyptian symbols resemble the European drawing. Fragments taken from [1100], [1291], [1062], [90] and [544], Volume 6.

must be what the author of zodiac EB tried to communicate by his drawing.

One might wonder why we discuss at such length even those of the Egyptian zodiacal symbols which appear to bear no direct relation to the purposes of astronomical dating, as was the case with the extra figure in Capricorn in the EB zodiac. The matter is that before one attempts to date one zodiac or another, one has to analyse all of the symbols it contains with as much care as possible, verifying the fact whether or not the symbol in question is related to astronomy in each case. Otherwise we are bound to repeat the errors of Morozov and other predecessors of ours who would extract a minimal set of astronomical symbols they deemed necessary for astronomical dating from each zodiac, disregarding all other symbols or considering them unrelated to astronomy. This would

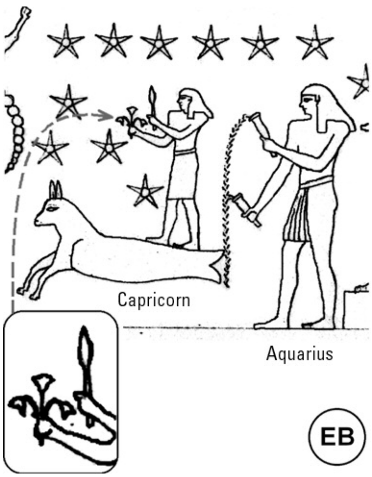


Fig. 15.17. EB zodiac from the Greater Temple of Esna (a fragment). The man standing over the symbol of Capricorn is holding a very small symbol in his hand, which resembles the already familiar "pole" that symbolises summer solstice to a great extent – the second version of the symbol, one with two bent poles on the sides, qv in fig. 14.10. A close-in of the man's hands and the symbol in question is at the bottom of the drawing. Based on [1100], A. Vol. I, Pl. 79.

lead to incomplete decipherments and loss of valuable information, which would affect the end result of astronomical dating at the end of the day.

1.11. Aquarius

Aquarius is the zodiacal constellation that we shall consider next. Its Egyptian drawings, as well as Dürer's rendition, can be seen in fig. 15.18. In the Egyptian drawings we see Aquarius as a male figure pouring water from two pitchers that he has in his hands. In the DR zodiac (the Round Zodiac of Dendera) we can even see who it is that he pours this water over – a fish, qv in fig. 15.18 (DR). However, the fish was one of the most widely used symbols of Christ in the Middle Ages, qv in [936], for instance. It turns out that Aquarius pours water over Christ, which makes the former a symbolic representation of John the Baptist.

Indeed, this theory finds vivid proof in Egyptian zodiacs. Let us point out that in the zodiacs DR, DL and EM the sign of Aquarius is accompanied by a number of symbols depicting decapitation in one way or another. In the Round Zodiac of Dendera (DR) we see a headless animal next to the head of Aquarius, whereas in the Long Zodiac of Dendera there is a headless male figure walking in front of the Aquarian figure. In the very same place we find the picture of a man holding a knife in one hand and some animal by its ears in another, clearly with the intention of decapitating the latter, qv in fig. 15.18 (DL). We see a similar scene in the zodiac DR right above the head of Aquarius, the sole difference being that the male figure isn't holding any knife; however, it is possible that the knife became lost over the years, since the scenes coincide in all other details, and are found in the exact same place – the Aquarius constellation.

Furthermore, in the EM zodiac from the Lesser Temple of Esna we see nine kneeling headless human figures surrounded by knives next to Aquarius – once again, a clear reference to decapitation.

One is reminded of the famous Evangelical story about the dance of Salome before Herod and asking the head of John the Baptist as a reward for her dance. Herod sent a soldier to the prison where John was kept, who had beheaded the latter and taken John's head to Salome on a dish. A famous Christian holy day commemorates this event, falling on the 29th August old stile. It is a fasting-day in the Orthodox church.

The vivid parallels between the way Aquarius is drawn in the Egyptian zodiacs were pointed out by N. A. Morozov himself in [544], Volume 6, page 679. This is most likely to be the case, and the Aquarius sign had indeed been used for referring to John the Baptist at some point. We shall discuss the Christian origins of old astronomical symbolism in detail in CHRON7, Chapter 16. On the other hand, the "extremely ancient" Egyptian symbolism also turns out to be filled with Christian motifs. This appears to be the forgotten symbolism pertinent to early Christianity of the XII-XV century. We shall return to this issue once we finish with the dating of the Egyptian zodiacs.

Let us now consider Dürer's rendition of the Aquarius. In his drawing Aquarius is holding a pitcher of water in one hand, and a towel folded in two in the other, qv in fig. 15.18. It is possible that we see the towel hanging from the shoulder of Aquarius in other Egyptian zodiacs, qv in fig. 15.18 (DR, AV). This is quite in order if Aquarius is indeed John the Baptist, since a baptised person is wiped dry with a towel after the baptism. Incidentally, one sees men with a piece of

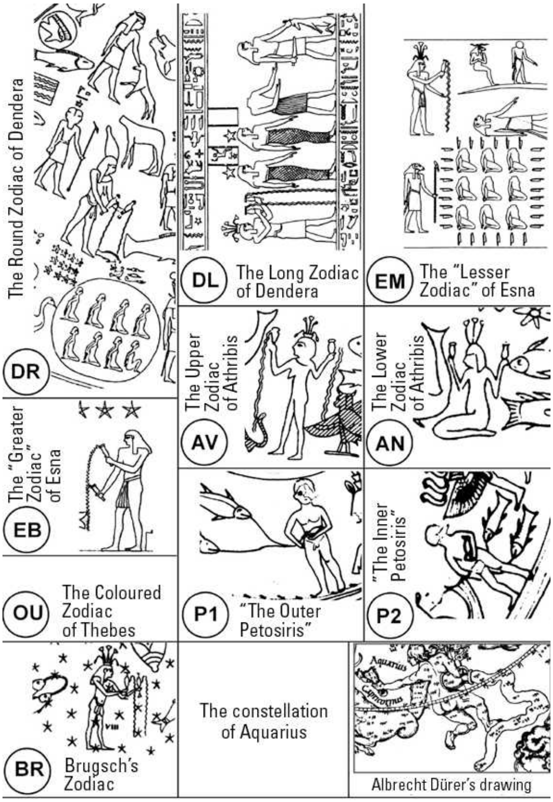


Fig. 15.18. Symbols of Aquarius from different Egyptian zodiacs. We don't find this constellation in the "Coloured Zodiac" from Thebes. Mark the fact that in the zodiacs DR, DL and EM the sign of Aquarius is accompanied by symbols of decapitation. Aquarius must have been a symbol of John the Baptist in the ancient zodiacs – someone who had poured water over Christ and baptised the latter, and was subsequently beheaded. Fragments taken from [1100], [1291], [1062], [90] and [544], Volume 6.

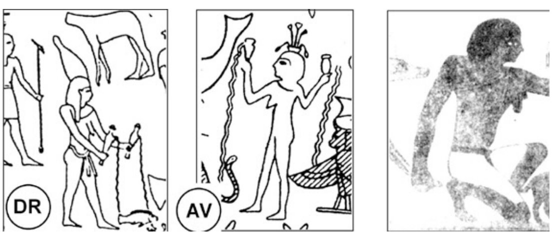


Fig. 15.19. Left to right: 1) Aquarius in the Round Zodiac of Dendera (DR); 2) Aquarius in the Upper Zodiac of Athribis (AV); 3) Ancient Egyptian drawing with a man who has a piece of cloth tied around his shoulder and hanging from it in the same manner as the figure of Aquarius in the zodiacs DR and AV. Taken from [544], Volume 6, page 955.

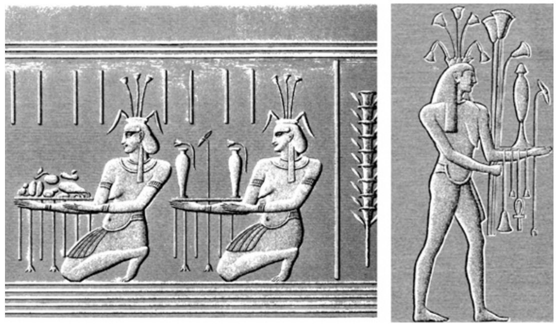


Fig. 15.20. Artwork on the pylons of the temples from Isle Philae (left), and from the Karnak temple (right). Fragments of drawings from the Napoleonic Egyptian album. The figures are very similar to the Egyptian drawings of Aquarius. Taken from [1100], A. Volume I, Pl. 12, and [1100], A. Volume III, Pl. 47.

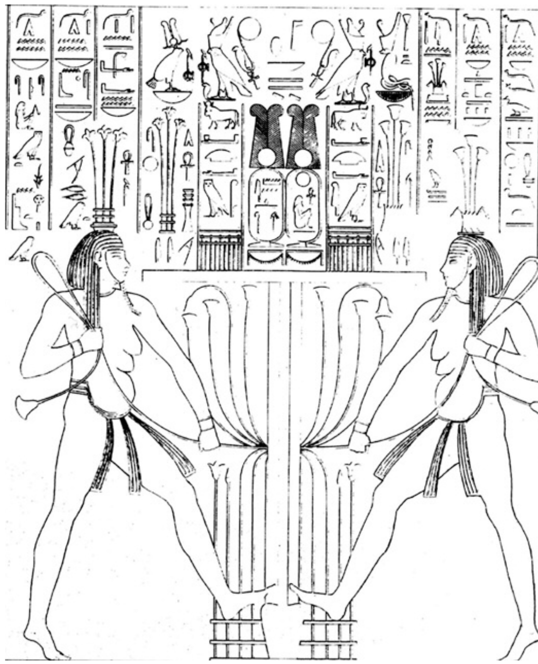


Fig. 15.21. Artwork from one of Memnon's colossi in Egypt near Luxor, on the way to the Valley of the Kings. We see two men, very similar to the figure of Aquarius. They wear similar headdresses and loincloths. Both figures have beards; we see something hanging off their chests that looks like two large creases – either on their attire or the actual bodies, likewise the figure of Aquarius in some of the zodiacs. Our comparison with the modern photographs demonstrated this copy done by the Napoleonic artists to be very precise. Taken from [1100], A. Vol. II, Pl. 22.

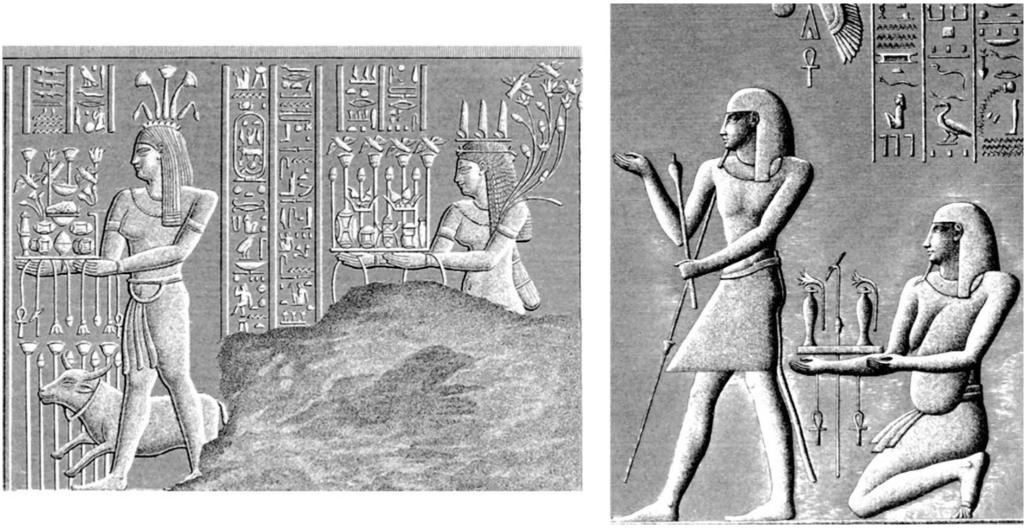


Fig. 15.22. Artwork from the Temple of Esna (left), and a fragment of a relief from the Karnak temple (right). Drawings from the Napoleonic Egyptian album ([1100], A. Vol. I, Pl. 81; A. Vol. III, Pl. 37).

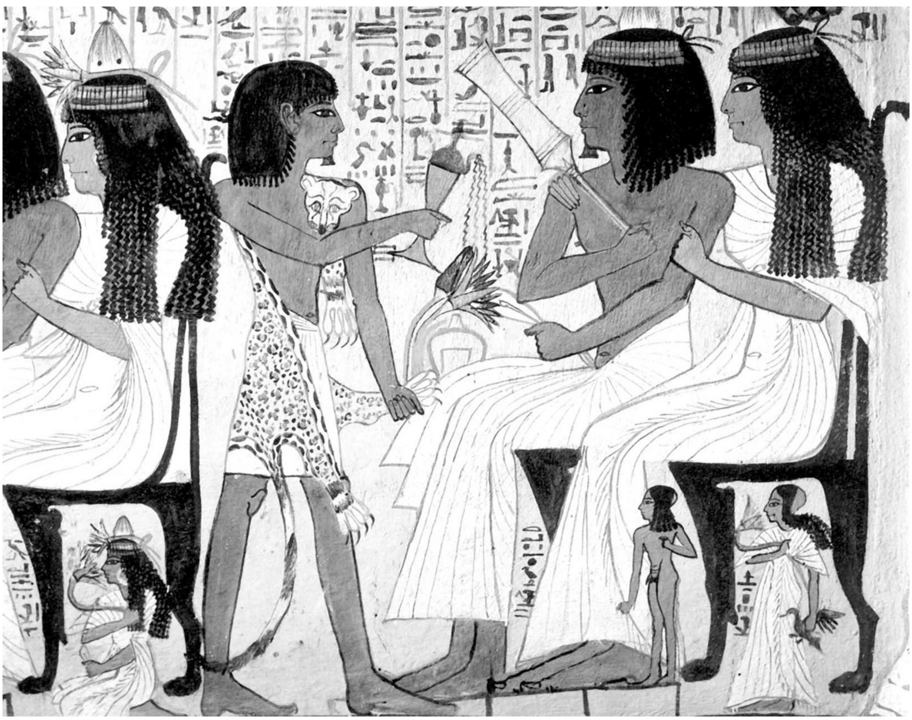


Fig. 15.23. Ancient Egyptian coloured fresco from the so-called "grave of Sennedjem in the valley of the craftsmen" near Luxor. We see someone wearing the hide of a lion, pouring water over some distinguished person sitting on a chair together with his wife, as well as their children. Apparently, what we see here is a baptism of a family by John the Baptist dressed in the hide of a beast, as written in the Gospels. The latter tell us that John the Baptist baptised many people; apparently, we see one of these baptisms in the ancient mural. Taken from [499], page 91.

cloth hanging from their shoulders in a similar manner in other Egyptian drawings as well, qv in fig. 15.19.

On the other hand, one often encounters figures resembling Aquarius in Egyptian temples – with a similar head-dress, for instance, looking like three stems or feathers pointing upwards, with two broken stems at the sides, qv. in fig. 19.18 (DL, EM, AV and BR), in a similar loincloth and so on. One sees several examples of such "ancient" Egyptian drawings in figs. 15.20, 15.21 and 15.22. These illustrations were taken from the Napoleonic Egyptian album ([1100]); one should therefore bear in mind that they may have undergone a number of stylistic alterations. However, in case of fig. 15.21, we have had the opportunity of comparing such a copy with the original, or a drawing from one of Memnon's Egyptian colossi, and we discovered the drawn copy in question to be very precise indeed.

In all of the pictures listed above one sees with perfect clarity that the figure of Aquarius has something hanging underneath its shoulder – it occasionally looks like a female breast, although the figure itself is distinctly male and sometimes even sports a beard; furthermore, the female figures one sees in Egyptian zodiacs have their breasts drawn differently, as one can clearly see in the illustrations above. It is therefore possible that the object in question is a piece of clothing rather than a breast, although what it could be exactly isn't quite clear. The only thing that remains beyond doubt is the fact that the odd bodily part (or piece of clothing) was definitely related to Aquarius as drawn in the Egyptian zodiacs.

Let us recollect the Evangelical description of John the Baptist's attire: "And the same John had his raiment of camel's hair, and a leathern girdle about his loin" (Matthew 3:4). This can be interpreted in a variety of ways; it is possible that the garment in question was made of animal hides – camel, for instance. At the very least, many icons and several pictures portray John the Baptist dressed in furs. Let us cite another interesting "ancient" Egyptian drawing in fig. 15.23. It is a coloured fresco from the so-called "crypt of Cennedien in the valley of the craftsmen" near Luxor. We see a man wearing furs with a vessel in his hand, which looks just like the pitchers carried by Aquarius in Egyptian zodiacs. He is pouring water over some official who sits in front of him accompanied by his wife. There are two figures of children near the legs of the chair, presumably the official's. The entire picture is very likely to depict a family baptism of the husband, the wife and the children. If this is the case, it is quite possible that they're baptised by John the Baptist himself, dressed in furs. Let us remind the readers that John baptised a great many people – not just Christ. It is possible that we see one such baptism in this old Egyptian mural.

Mark the way in which the fur piece is draped over the shoulder of the man with the pitcher (John the Baptist) in fig. 15.23. One sees a great semblance between it and the object that hangs over the shoulder of Aquarius in some Egyptian zodiacs (the Round Zodiac of Dendera in particular, qv in figs. 15.18 (DR) and 15.19. Thus, it is possible that a piece of the fur garment that Aquarius (John the Baptist) was dressed in had hung over his shoulder, which is duly reflected in the "ancient" Egyptian zodiacs.

As we shall see below, identifying Aquarius as John the Baptist is perfectly in line with the astronomical datings of the Egyptian zodiacs, according to which all of the zodiacs in question date to a much later epoch than one is accustomed to believe, when Christianity had already been a widespread religion, and Egypt a Christian country. This issue, which is of the utmost interest indeed, shall be addressed additionally in the following volumes. See also our books entitled ***Empire, Russia and Rome,*** and ***A Reconstruction of Global History.***

We must point out that Aquarius is almost always depicted naked in the Egyptian zodiacs, or wears nothing but a loincloth, qv in fig. 15.18. It has to be noted that one doesn't see that great a deal of naked figures in the Egyptian zodiacs – a great deal less than clothed ones, at any rate. Let us also remind the reader that John the Baptist baptised Christ in the waters of Jordan, according to the Gospels. In some of the icons depicting the Baptism of Christ John the Baptist is standing in the Jordan river, likewise Christ – naked, naturally, just like Aquarius in the Egyptian zodiacs.

Thus, we have considered eleven zodiacal constellations. The one that remains is Pisces.

1.12. Pisces

The drawings of the Pisces in the Egyptian zodiacs and their picture by Dürer can be seen in fig. 15.24. At any rate, the constellation in question is represented

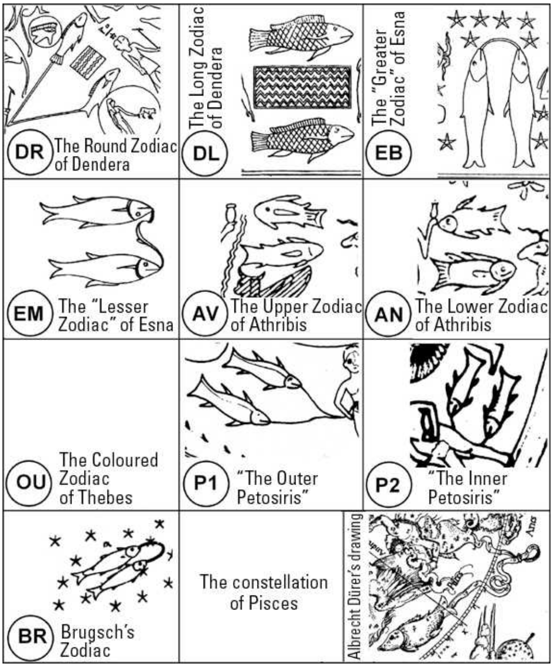


Fig. 15.24. Symbols of Pisces from different Egyptian zodiacs. We don’t find this constellation in the “Coloured Zodiac” from Thebes. Fragments taken from [1100], [1291], [1062], [90] and [544], Volume 6.

by two fish figures which are often tied to one another with a string or a band. It is easy to recognize the symbol of this constellation in the Egyptian zodiacs; this applies to all the other constellations as well. In general, it isn’t hard to recognize any of the constellational symbols used in the Egyptian zodiacs, inasmuch as they’re drawn in pictorial form.

However, in some of the Egyptian zodiacs one finds no constellation figures whatsoever. This is most often the case with the zodiacs from Luxor – the so-called “Theban” zodiacs, since the city of Thebes in Egypt as mentioned in the chronicles is identified as the modern Luxor ([499], page 3).

In the zodiacs of the “Theban” type the zodiacal belt may simply be divided into fragments containing astronomical symbols. Such is the zodiac from the crypt of Ramses VI in the Valley of the Kings near Luxor, for instance, qv in fig. 15.25. Decipherment of such zodiacs usually involves an additional study to determine the exact segments contained in a constellation, which usually complicates the decipherment a great deal.

Among the zodiacs of the Theban type we find the likes of the zodiac that we already cited in fig. 12.1. One encounters representations of this zodiac in the souvenir papyri sold in Egypt, as well as Egyptian postcards nowadays ([623:1]). Apparently, it comes from one of the ancient temples or sepulchres in the vicinity of Luxor, although we didn’t manage to estimate its exact location. In this zodiac we see a row of vertical lines separating the Zodiacal belt into 36 segments instead of the constellational symbols, qv in fig. 15.26. The implication is that each of the zodiacal constellations is separated into three parts, with the entire ecliptic separated into $3 \times 12 = 36$ parts. We see no symbols of zodiacal constellations here whatsoever; therefore, one can only guess at which of the drawings might pertain to one zodiacal constellation or the other, or sort through all possibilities. It is also possible that the ecliptic isn’t separated into constellations, but rather equal 10-degree segments. Bear in mind that the entire ecliptic circle contains 360 degrees all in all, and could thus be separated into 36 equal 10-degree parts, in which case each of the constellations will occupy three such segments, or 30 degrees, on the ecliptic. However, the precision of such division shall be very approximate, since the zodiacal constellations are not uniform in size. Such ambiguity of the drawing naturally complicates the astronomical dating of the zodiacs of this tipe.

Another example. Let us turn to the “Coloured Theban Zodiac” which is already known to us (see OU in fig. 12.3, for instance). Bear in mind that in had been discovered during the Napoleonic expedition in one of the sepulchres from the necropolis in Luxor (“Thebes”) in the “Valley of the Kings”. We have in front of us another zodiac of the Theban type, where we just see the drawings of the constellations that had contained planets on the date ciphered in the zodiac.

The figures of all such constellations are collected in the middle part of one of the OU zodiac’s halves, qv in fig. 15.27. Here we see Leo, Scorpio and Taurus. We encounter no familiar symbols for any of the other zodiacal constellations, the apparent reason being that the constellations void of planets on the date ciphered in the zodiac would not be drawn, qv below in our analysis and dating of the OU zodiac.

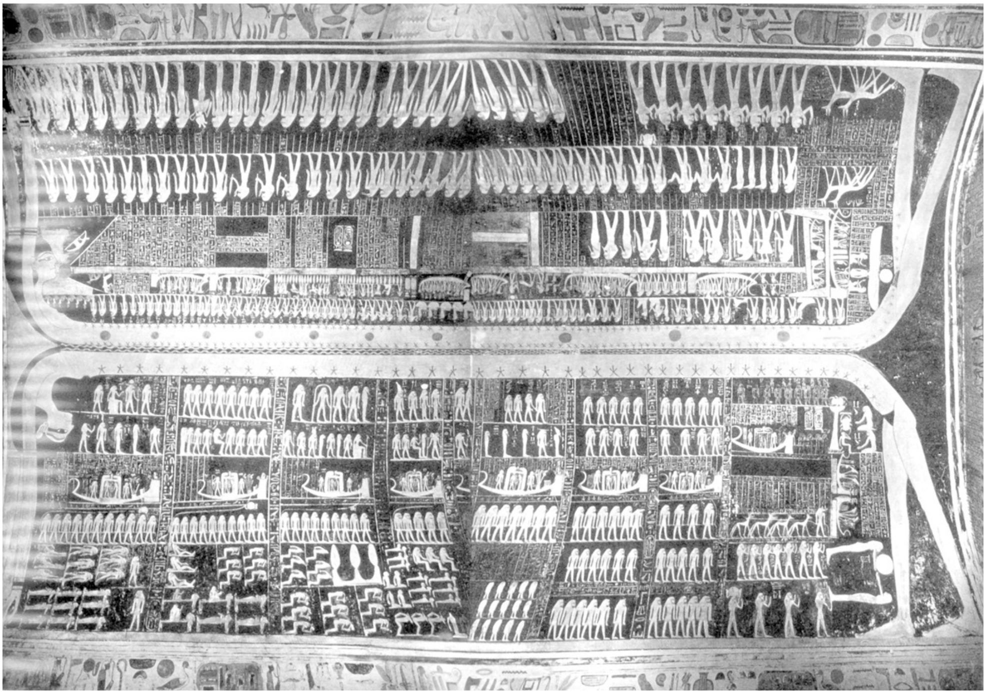


Fig. 15.25. Zodiac painted on the ceiling of the royal Egyptian sepulchre of Ramses VI in the Valley of the Kings near Luxor. Taken from [1017:1], pages 128-129.

2. THE TEN-DEGREE SYMBOLS AND THE "RESOLUTION" OF THE EGYPTIAN ZODIACS

2.1. The ten-degree marks in the Long Zodiac (DL)

Above we mention the fact that in some of the Egyptian zodiacs, namely, those of the "Theban type", the division of the zodiacal strip into 36 parts appears to be used as a substitute of the missing constellational symbols. In other words, in the zodiacs of the "Theban type" the ecliptic isn't divided into segments with the use of zodiacal constellation drawings found alongside the strip, but rather a mere 36 segments, qv in fig. 15.26 mentioned above. It is easy to calculate how many parts each constellation becomes divided into if we divide 36 segments by 12, which is the number of the zodiacal constellation. We come up with 3 segments per constellation. It is therefore highly likely that each zodiacal constellation is represented by a certain sequence of three such segments in the "Theban" zodiacs.

This theory is confirmed well by the Long Zodiac of Dendera. N. A. Morozov pointed out that each of the zodiacal figures encountered there is accompanied by two additional symbols, those of young women with stars over their heads, all of them resembling each other (see fig. 15.28). There are 24 of them in the Long Zodiac of Dendera altogether; they add up to 36 figures together with the 12 figures of the zodiacal constellations and thus divide the entire zodiacal stripe (which has the shape of a ring) into 36 parts (there would be 37 of them otherwise).

N. A. Morozov wrote the following in this respect: "Behind Leo and Virgo one can easily recognize figures of the other constellations, each of them accompanied by a pair of maidens (one in front and the other behind for the most part) … together with the 12 zodiacal figures they stand for 36 1/2 ten-day periods" ([544], Volume 6, page 675). Let us explain that Morozov is referring to 36.5 10-day periods that

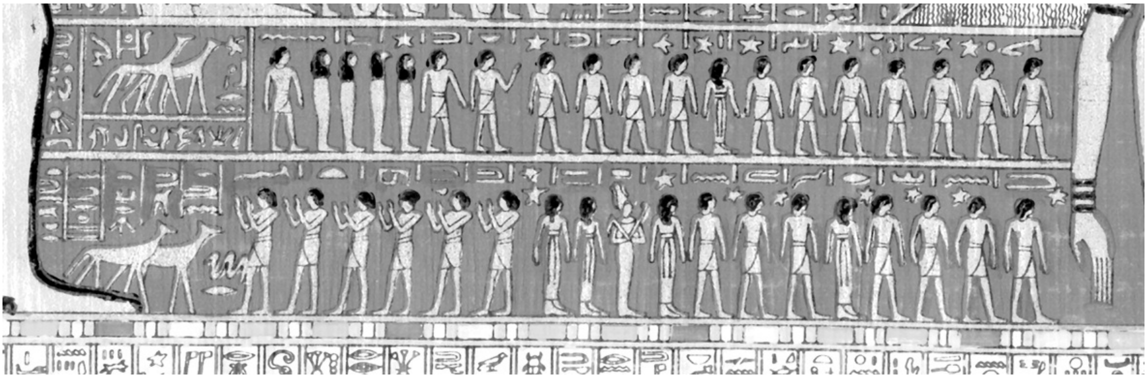


Fig. 15.26. Fragment of the Egyptian zodiac from fig. 12.1. Here we see a simple row of vertical lines that separate the zodiacal belt into 36 parts instead of constellation figures. Since the latter aren't drawn anywhere, we can only guess about which parts of the drawing correspond to which constellations, qv in [623:1].

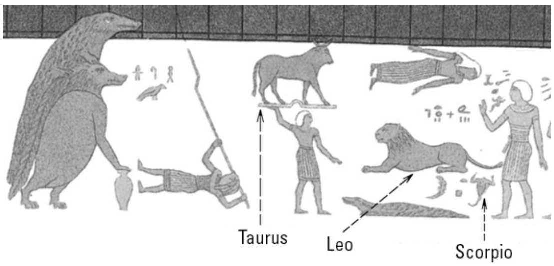


Fig. 15.27. Fragment of the "Coloured Theban Zodiac" (OU) with the constellation figures. Only three of the constellations that we find here are drawn in the conventional manner – Leo, Scorpio and Taurus. We see no other familiar constellation symbols in this zodiac. The reason must be that they didn't contain any planets on the date transcribed in the zodiac. Taken from [1100], Plate 82.

a 365-day year comprises, since the division of a zodiacal belt into 36 parts can also be interpreted as the division of a year into a similar amount of parts, or segments of roughly ten days. This relates to the fact that it takes the Sun a year to pass through the entire zodiac (the half-day discrepancy between this so-called "stellar year" and the 365-day year is of no importance to us whatsoever). The ten-day periods shall refer to the ten-degree arc segments, 36 of them altogether, comprising a full 360-degree circle.

We shall witness this idea of Morozov's to be perfectly correct. However, when he tried to determine which female figures pertain to one zodiacal constellation to another, he made a few errors ([544], Volume 6, page 679). These errors are partially explained by the fact that Morozov had only possessed the drawn copy of the Long Zodiac taken from Bode's ***Uranography*** (figs. 13.3 and 13.4), which is of a very poor quality, as we already mentioned. However, some of the mistakes made by N. A. Morozov simply testify to his not being attentive enough in this case.

For instance, he writes that "Sagittarius is followed by two maidens, which stand for its last two ten-degree segments; in between the two we see the slaughter of a mythological beast which is held on a chain by a dog. Next we see the figure of Capricorn that marks its second ten-degree segment … followed by the third such segment in its usual representation, that of a maiden … the next figure in Capricorn is represented by a naked woman [wearing a semi-transparent dress in the Napoleonic album, qv in fig. 15.28 – Auth.] transferred to the other hemisphere (via the hands of the goddess Nuit)" ([544], Volume 6, pages 678-679).

However, we only see two young women between the figures of Sagittarius and Capricorn, qv in fig. 15.28. Let us point out that in the illustration from Bode's ***Uranography*** used by Morozov one can clearly see two female figures between Sagittarius and Capricorn. However, if both of them relate to Sagittarius, as Morozov tells us, standing for the second and the third ten-degree segment of the constellation, how can Capricorn represent its second ten-degree segment? Where is the female figure representing the first such segment? We see none on the drawing; the

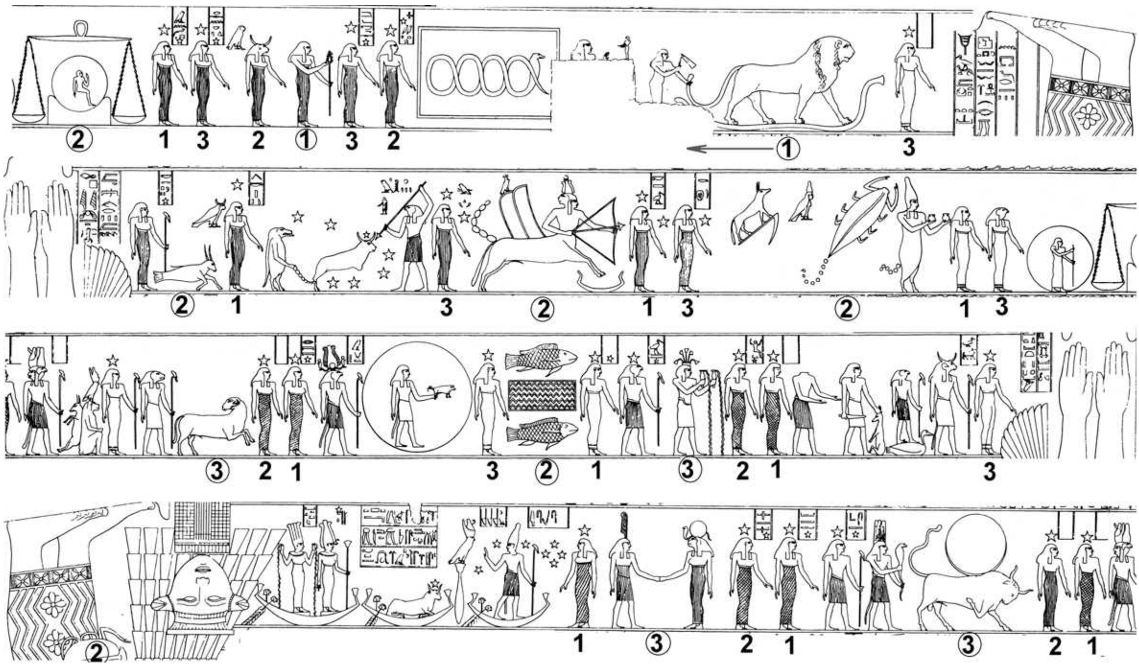


Fig. 15.28. The Long Zodiac of Dendera (DL) with the female ten-degree figures. The latter are numbered. Based on the drawn copy from [1100], with a number of corrections based on [1062:1].

figure of Capricorn immediately follows the two female figures we see after Sagittarius (fig. 15.28). We see that Morozov's explanations contain a certain flaw or vagueness.

Some of the flaws are even more manifest. Thus, Morozov first refers to the figure of Scorpio as the representation of the constellation's last ten-degree segment; several lines later it transforms into the first, no less, since, according to Morozov, it is followed "once again" by the second and the third ten-degree segments of Scorpio. Morozov's text is as follows: "Before the last ten-degree segment of Scorpio, represented by the actual constellational symbol, we see a very strange figure – some animal with a tail … Scorpio is followed by a jackal, a serpent [a scythe and not a serpent in reality, but Morozov's copy of the drawing had been of very poor quality – Auth.] and a falcon, once again accompanied by the second and the third ten-degree segments of this constellation in their usual maiden form" ([544], Volume 6, page 678).

One also feels very doubtful about Morozov's explanations in re the ten-degree figures in Leo, whose representation in the Long Zodiac has a number of considerable flaws ([544], Volume 6, page 678; see also fig. 28). And so on, and so forth.

Let us delve into this issue once again and try to understand whether the female figures in the Long Zodiac of Dendera really complement the 12 constellational figures to make 36. If this is indeed the case, there must be 24 of these maidens. Their distribution across the zodiac should give 12 triads together with the constellational figures, each triad containing two female figures and one constellational figure. It is natural that the figures from different triads should not mingle with each other – that is to say, the triads must follow each other on the zodiac without overlapping, as is the case with the zodiacal constellations on the zodiacal belt of the real celestial sphere.

This is indeed the case. Moreover, there is only one way of dividing the figures of maidens and constellations into twelve such triads. This division can be seen in fig. 15.28 as numbers written underneath the strips of the Long Zodiac. Their sequence in every constellation is indicated as "1, 2, 3", and there are 12 such

sequences altogether. The numbers located underneath the actual zodiacal figures are circled; thus, in each number triad referring to a single constellation we have a single circled number under the figure of the constellation itself. Two other numbers without circles are located underneath the ten-degree symbols from the given constellation (the "maidens").

Of course, the enumeration as seen in fig. 15.28 is dependent on the direction of the numbers, which is indicated by the arrow sign underneath Leo – towards the general procession of the figures. The reverse direction requires all the figures of 1 and 3 to swap their respective positions. Bearing this in mind, one can say that the ten-degree segment enumeration in fig. 15.28 is absolutely unequivocal, and we shall demonstrate this below.

For the meantime, let us point out that the enumeration in question allows us to clarify the issue of the maiden with a rod, which she rested on the back of Capricorn, qv in fig. 15.28, as well as the young woman in a transparent dress that follows her across the hands of Nuit in the next strip of the zodiac, which Morozov calls "naked", following the erroneous illustration from Bode's ***Uranography***. As we have seen, Morozov considered only the first of the female figures (with a rod) to be a symbol of a ten-degree segment, and not the second, which has no rod. Now we can be certain that this is an error from the part of N. A. Morozov.

This error is partially explained by the fact that in the ***Uranography*** used by N. A. Morozov the first female figure has no rod, for some reason (fig. 13.4), although we can see it perfectly well in the drawn copy from the Napoleonic album ([1100]). This rod is a planetary symbol; no other figures in the Egyptian zodiacs can be seen with any rods of any kind. Let us point out that not a single ten-degree female figure has got a planetary rod in the Long Zodiac.

On the contrary, the second female figure that Morozov had erroneously excluded from the group of ten-degree segment symbols, hardly differs from any of the other such figures at all, the only difference being that her dress is drawn as semi-transparent, according to the illustration from the Napoleonic album ([1100]), whereas the dresses of the other such figures are black. However, this does not preclude the female figure in question from standing for a ten-degree segment; the important thing is that the position of this figure's body and arms is just the same as those of all the other ten-degree segment female figures.

Morozov must have been let down by the poor quality of the ***Uranography*** illustration, qv in fig. 13.4, where the female figure isn't wearing any dress at all, for some odd reason, which really makes her resemble her companions very little.

In order to prove the fact that N. A. Morozov had made an error, let us assume that he was correct and include the woman with a rod in the group of ten-degree segment symbols, excluding the figure in a transparent dress from said group. It turns out that one can find no satisfactory means of dividing the ten-degree segments into triads, since one of the triad is bound to have no constellation symbols whatsoever, whereas another will have two. It is easily demonstrated – one has to go through all possible versions with the aid of fig. 15.28.

The only possible solution for the distribution of the ten-degree segments over the Long Zodiac and their division into constellational triads is the one seen in fig. 15.28.

Let us prove it. One has to bear in mind that we see a single solitary female figure between the signs of Pisces and Aquarius, qv in fig. 15.28. We have only got two choices here – either we are to consider this figure to stand for the first ten-degree of Pisces, or the last one from Aquarius. Each of the versions shall either lead to a contradiction, or to an equal enumeration of ten-degree segments along the entire zodiacs. Indeed, once we know the number of the female figure (the first of Pisces, for instance), we can follow the zodiac in either direction and ascribe numbers to all the other constellations. It is easy to verify that a correct distribution of numbers is only achieved in one case – if we consider the female figure a Piscean ten-degree segment and not Aquarian, qv in fig. 15.28.

2.2. The division of the ecliptic into 36 parts and the exactness of planetary representations in Egyptian zodiacs

The fact that we found ten-degree segments in the Long Zodiac might give us hope that the positions of planets in it are a great deal more precise than usual. This would have been the case, had the planetary

symbols inside a given constellation been positioned between the symbols of its ten-degree segments, which would make the planetary locations three times more precise, the segments being three times smaller than a constellation on the average.

However, this hope is false. The Egyptian author of the Long Zodiac places all the planetary symbols except for the Sun and the Moon in the intervals between the ten-degree segment triads; we find no other planet of the primary horoscope inside any triad whatsoever. Had we found any, we could attempt to estimate the planet's position in a given constellation with more precision. This doesn't happen to be the case with the Long Zodiac, as one sees in fig. 15.18 – all it takes is a careful study of how the planetary figures with rods are positioned. The only ones we find inside triads are either standing in boats, or have their rods lean against other symbols, like the young woman near Capricorn. As we shall see below, all such figures pertain to secondary horoscopes, and their positions indeed correlate to their positions inside constellations.

We encounter another noteworthy detail here, which is worthy of pointing out. It bears no direct relation to the actual dating, but can give one a good idea of the methods generally used in Egyptian astronomical symbolism.

As is the case with all the other Egyptian zodiacs, the figures from the Long Zodiac are headed in the same direction going from left to right, qv in fig. 15.28. This is the case with the ten-degree segment female figures in particular. It is just one of them that faces the opposite direction, the female figure that symbolizes the first ten-degree segment of Cancer. Why would that be? Let us study this issue deeper. Mark the fact that the figure is followed by a male with his hand raised high, standing in a boat. He is holding a planetary rod, qv in fig. 15.28. We are already familiar with the symbol in question, and shall return to it below, in the section that deals with the symbols of equinoxes and solstices. This particular symbol stands for the summer solstice in Gemini – however, it is drawn between the first and the second ten-degree segments of Cancer, or shifted from its usual place in Gemini towards Cancer. This explains why the female figure that precedes it is facing the opposite direction – the proper position of the solstice point is in front of the young woman, right in front of her face, or in Gemini. However, the solstice symbol is on her other side, and she is turned towards it the way she should be.

In other words, the figure of the young woman swapped places with the solstice symbol, and the Egyptian artist had to make her face the opposite direction, where he placed the symbol in question. We are in no way saying that he tried to rectify his error – he must have planned everything in this manner; what we're witnessing is one of the methods of the ancient Egyptian astronomy in action.

What are the conclusions one could make from the above? The most important one, to us, is the fact that the division of the zodiacal belt into 36 parts that we see in some of the Egyptian zodiacs is the very same division into zodiacal constellations, each of the latter being represented by a sequence of three segments.

It has to be said that one could theoretically allow for another possibility – namely, that the ecliptic is simply divided into 36 equal parts in such zodiacs, with no accounting for the zodiacal constellations, since the latter do not equal each other in the direction of the ecliptic. Therefore, the marks used for such uniform division of the zodiacal belt would a priori be shifted in relation to the constellation boundaries; furthermore, one would be confronted with the problem of estimating the initial reference point of such uniform division, seeing as how it isn't affixed to any boundary between constellations. This would gravely complicate the research and the decipherment of such zodiacs.

However, if we are to consider the Long Zodiac of Dendera, the division of the ecliptic into 36 segments in the Egyptian zodiacs of the "Theban type" as seen in fig. 12.1 is most likely to conform to the same principle as the "regular" Egyptian zodiacs, being just another way of dividing the ecliptic into zodiacal constellations.

3. DISTINGUISHING BETWEEN THE MALE AND THE FEMALE FIGURES IN THE EGYPTIAN ZODIACS

In order to address the issue specified in the heading of the section, let us consider the abovementioned illustration where one sees a collection of various

Egyptian astronomical symbols, qv in fig. 14.7. A study of the drawing might lead us to the useful observation, which shall often assist us in our analysis of the Egyptian zodiacs and their symbolism, and is confirmed by every Egyptian zodiac known to us. This observation concerns the differences between the male and the female figures in the Egyptian astronomical symbolism, and happens to be important enough. The quality and condition of the artwork found on the ancient zodiacs are often far from perfect, unfortunately; therefore, one often has doubts about the gender identity of one figure or another. This issue may be vital for the decipherment of the symbol in question, and the horoscope in general.

If we are to study fig. 14.7 attentively, it is easy to notice that the male and female figures differ from each other drastically in the Egyptian zodiacs, the distinctive characteristic being the width of their steps, which is a lot greater in case of male figures, qv in fig. 14.7. This law of Egyptian symbolism is followed in every Egyptian zodiac without exception. Therefore, should we doubt the sex of any figure at all, it suffices to look at the width of said figure's step; this is a method we shall use often.

The only case when this method cannot be applied is when the figure is drawn with both feet seen as one when viewed sideways, qv in fig. 14.7. There are a few such figures in Egyptian zodiacs; fortunately, they don't stand for planets as a rule, and their sex is therefore of secondary importance for the purposes of astronomical dating.

The readers can easily witness that "the rule of step and gender" is followed in every Egyptian zodiac without exception, and in every Egyptian drawing in general. It suffices to study the numerous drawings of the Egyptian zodiacs that we cite in the present book, or indeed any illustrated book on Egypt.

4. PLANETARY SYMBOLS OF THE PRIMARY HOROSCOPE

4.1. The planetary rod

As early as the XIX century, the first European researchers of the Egyptian zodiacs had discovered that the planetary figures on them usually look like wayfarers carrying rods which are topped in a special way, not just ordinary sticks – usually t-shaped, visibly leaning forward, qv in fig. 15.29. These "planetary rods", as we shall be referring to them henceforth, can be seen held by planetary figures in most of the Egyptian zodiacs. In the abovementioned fig. 14.7 each of the figures is holding a planetary rod. We already mentioned the fact that it isn't the mysterious "ancient Egyptian gods" collected in this illustration, as the Egyptologists think, but rather the Egyptian planetary symbols. We shall come across many of them in our analysis of the Egyptian zodiacs.

N. A. Morozov cites typically Egyptian planetary figures in his study of the Egyptian zodiacs ([544], Volume 6). All of them without exception have planetary rods with t-shaped tops in their hands, qv in fig. 15.30.

Why is it the rod that serves as the distinctive characteristic of planets in the Egyptian zodiacs? This is easy to understand. The rod was a symbol of movement and being on a journey in the Middle Ages, being the obvious accessory of a traveller. This is why it must have been chosen by the Egyptian artists as a distinctive planetary characteristic. Let us remind the reader that planets were considered to be "wandering stars" in old astronomy – wayfarers, in other words.

Planets look exactly like stars to the naked eye; however, they are different in the sense that they constantly move and alter their position on the celestial sphere. Real stars, on the other hand, do not change their position in relation to each other, which results in the celestial sphere looking the same for many centuries (it is hence referred to as the "immobile star sphere"). The planets move across the imaginary celestial sphere, moving along the same circular itinerary slowly, but unevenly. If we are to draw this path on the celestial path, we shall come up with a circumference. Planets occasionally stop on their way and begin reverse movement, then turn back once again and continue to move forward. This so-called "retrograde motion" results from the combined rotation of the Earth and the planets around the Sun.

In astronomy the planetary track on the celestial sphere is called the ecliptic circumference, or the Zodiac belt. It takes different planets several weeks or months to move from one zodiacal constellation to another along this track. Ancient astronomers used

to consider planets mobile stars. Old Russian and Byzantine chronicles (the chronicle of John Malalas, for instance) would explicitly use the term "wandering star" ([503], page 195). This is why planetary figures from the Egyptian zodiacs carry rods.

Let us point out that the Sun and the Moon also ranked as stars in ancient astronomy, since they move across the celestial sphere following the same trajectory as the planets from the point of view of an earth observer. This is why we shall occasionally refer to them as planets, which is incorrect insofar as modern astronomy is concerned, but facilitates the narration to some extent.

We haven't told the reader anything new so far. N. A. Morozov already knew about the planetary rods in the Egyptian astronomical symbolism, likewise his predecessors who studied Egyptian zodiacs. The planetary rod is the primary attribute for telling planets apart from other signs and figures, and is used by modern Egyptologists whenever they attempt a cautious discussion of the issue of dating the Egyptian zodiacs astronomically (see [1062] and [1062:1], for instance). All the planetary figures found in the Round Zodiac of Dendera by the modern researcher S. Cauville, for example, have planetary rods in their hands, looking just as described above ([1062]).

One is confronted by a certain problem here. The matter is that one usually finds more figures with rods in Egyptian zodiacs than it is required for all the planets one can see with the naked eye, of which there are five (apart from the Sun and the Moon) – Saturn, Jupiter, Mars, Mercury and Venus. Nevertheless, in the Long Zodiac of Dendera we find ten such figures, for instance, the number equalling nine for the Round Zodiac, etc. Of course, it is possible that certain planets could be depicted by several figures with rods – a "procession", as it were. Yet we usually find too many such "processions" for a single horoscope.

We have discovered the reason for this above, in our study of the Egyptian zodiacs. The matter was addressed above – it turns out that there isn't just one horoscope that we find in a given Egyptian zodiac, but several of those at once. The only complete horoscope is usually the main one, which stands for the actual date that the horoscope in question was compiled and drawn for. Other horoscopes are secondary and incomplete. They are related to the astronomical description of a calendar year that contains the zodiac's primary date. Therefore one finds more planetary figures than one expects in the Egyptian zodiacs – some of the figures pertain to secondary horoscopes and not the primary one. As a result, some of the planets are represented several times in one and the same zodiac (once in the main horoscope, and, possibly, a few more times in the secondary ones).

Fig. 15.29. The drawing of a sitting person with a rod. Such rods are a distinctive feature of planets in Egyptian zodiacs. A fragment of mural artwork from an Egyptian tomb near Luxor (the so-called Inkherki tomb in the Valley of the Craftsmen). Taken from [499], page 94.

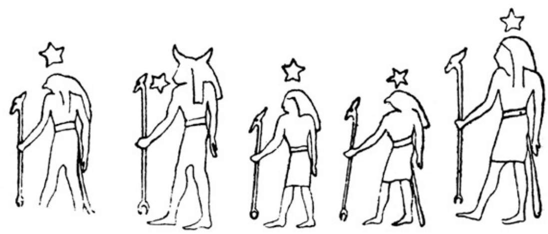


Fig. 15.30. "Typical drawings of planets from the Egyptian horoscope artwork". Fig. 182 from the book by N. A. Morozov ([544], Volume 6, page 956). All the figures are holding similar rods.

N. A. Morozov failed to realise this, and so he proposed that some of the figures should stand for something else but planets, despite being equipped with planetary rods. As we can understand now, this idea had been erroneous. N. A. Morozov followed it nevertheless, and tried to ascribe a non-astronomical meaning to the "extraneous" planetary symbols. This would lead to imperfections and contradictions in his interpretation of the zodiacs. We have cited some of them above, and shall refrain from carrying on with their list presently.

Let us formulate the principle behind our interpretation of the planetary symbols present in the Egyptian zodiacs. It is as follows.

Each and every figure that carries a planetary rod in an Egyptian zodiac stands for a planet, regardless of whether the figure in question is standing, sitting or walking. Alternatively, they can be participants of "planetary processions", which once again means that they accompany one planet or the other. Below we shall discuss the issue of telling the main horoscope's planets apart from those from the secondary horoscopes.

However, if the rod carried by a figure in the Egyptian zodiac is a mere stick with no special topping, the figure in question may well be a non-planetary one. We usually see these "unorthodox" rods carried by secondary horoscope figures, likewise the symbols that accompany a planet as its "procession" or "entourage". Their symbolism varies to a greater extent and isn't quire as strict as the one used for the planets of the primary horoscope. In the rare cases when the quality of the picture doesn't allow us to estimate what rod it is that the figure in question is carrying, we shall consider both possibilities at once.

There are Egyptian zodiacs where planets are represented differently – not as wayfarers. This isn't a frequent occurrence, but it takes place at times. In the Athribis zodiacs of Flinders Petrie, for instance (zodiacs AV and AN), all the planets except for the Sun, the Moon and Mercury are drawn as birds. In the zodiacs from the tomb of Petosiris (zodiacs P1 and P2) the planets look like waist-long portraits whose hands are out of sight altogether. In such cases there can obviously be no rods anywhere.

One has to emphasize that the identification of planets on the zodiac is one of the key moments of astronomical dating. The date that one gets as a result of astronomical calculations shall simply be incorrect if the figures are misidentified. On the other hand, one is occasionally faced with several identification options for one or the other zodiacal figure. The correct one is discovered as a result of astronomical calculations.

Let us explain the procedure of such calculations. Let's assume that a given zodiac allows for several options of identifying one planet or another. In other words, some of the planets can be found in a variety of methods, the correct one remaining unknown a priori. This is often the case with research in Egyptian zodiacs, and we shall keep running into such occurrences below. Is it possible to identify planets correctly in circumstances this ambiguous, likewise the veracious astronomical dating of the zodiac? The answer turns out to be in the positive. One can indeed do this for the overwhelming majority of Egyptian zodiacs owing to the secondary horoscopes that we have discovered therein.

We shall proceed as follows. In the first stage we shall consider all the astronomical solutions resulting from various planet identifications to be of equal validity, and then verify each one's correspondence to the secondary horoscopes of the zodiac in question. It turns out that "random" solutions don't withhold such tests, excepting the very brief and minimally informative zodiacs, and there are few of these. We shall witness the fact that the Egyptian astronomers and artists applied enough effort to exclude random or extraneous solutions from the zodiacs they created. In other words, they introduced enough additional astronomical information into these zodiacs for all of the random solutions to become redundant. As a rule, there is only one solution that satisfies to the entire symbolic content of an Egyptian zodiac.

After we do away with the extraneous solutions, we can return to the issue of veracious planetary identification. Bear in mind that each of the solutions that we arrived at during the first stage would be based on a decipherment of its own, or an a priori determined method of identifying planets. All such methods were of equal importance to us initially. However, once the correct solution emerges, we shall have the opportunity of specifying the correct planetary identification method with absolute precision. This will be the iden-

tification method that brings us to the correct astronomical solution, which we shall use as our finite method, rejecting all the other identification options that spawned solutions contradicting secondary horoscopes.

Thus, let is sum up.

The finite solution of the issue concerning the respective identity of the figures in the zodiac under study and the planets that they represent can only be reached after all of the zodiac's decipherment options undergo exhaustive calculations and are tested to comply with the secondary horoscopes. The final option is the one that yields an astronomical solution satisfying to all the parameters. There is usually just one such solution, which removes the ambiguity from the issue of planetary identification.

Below we provide an in-depth account of how each planet of seven (the Sun and the Moon included) were represented in the main horoscope of an Egyptian zodiac. In accordance with the above, the planetary figures in the zodiacs can be divided in two parts.

The first part is the Egyptian planetary images, which can be deciphered instantly, even before we begin with astronomical calculations. This shall be the case, for instance, if the identification of a certain planet from the zodiac directly stems from "ancient" mythology or old astral symbolism. Obviously, astronomical considerations also play a part in this.

Most of such cases were already discovered and studied in detail by our predecessors. It has to be said that the Egyptologists and the astronomers of the XIX and the early XX century were rather active in their search and interpretation of planetary symbols inherent in the Egyptian zodiacs. H. Brugsch, the famous XIX-century Egyptologists, had worked on it, as well as the astronomers Dupuis, Laplace, Fourier, Letron, Holm, Biot, Knobel, Viliev and a plethora of others ([544], Volume 6, pages 651, 632 and 633). Their efforts of many years were summed up in the fundamental work by N. A. Morozov on the astronomical dating of the Egyptian zodiacs ([544], Volume 6). Apart from that, N. A. Morozov voiced a number of new valuable ideas concerning this issue and corrected some of the errors in the interpretation of the zodiacs made by his predecessors. Some of the examples are cited above.

All of this concerns the first group of planetary figures – the ones which can be identified as respective planets with enough reliability based on a priori considerations.

The second group is constituted of the planetary figures that cannot be given a final identification during preliminary analysis. There are usually few such figures – just one or two per zodiac. However, even a single planet can significantly alter the result of the astronomical dating. Therefore, if we have doubts about so much as a single planetary figure, it is an absolute necessity to consider several interpretation options at once.

The situation when a single planet could be represented by several figures simultaneously isn't an uncommon occurrence in the analysis of Egyptian zodiacs. As we already mentioned, in such cases we go through all possible versions and perform astronomical calculations for each and every one of them. Finite identifications of planets only emerge at the very end of the research. More details can be found in the ensuing sections dedicated to the astronomical datings of actual zodiacs. In particular, we shall provide a description of our verification calculations that led to one or another identification of planets from a given zodiac.

In the present section we shall only cite the end result, or the main horoscope's planetary figures as interpreted for each of the zodiacs under study. Bear in mind that under the main horoscope of an Egyptian zodiac we understand the planetary disposition for the primary date encoded therein, which is the very date that the horoscope in question would be compiled for. Below we shall simply study the planetary figures of the primary horoscope, with the figures of the secondary horoscopes considered in the ensuing sections.

A list of the planetary symbols from the primary horoscope in the Egyptian zodiacs shall be presented as a sequence of seven drawings that corresponds to the number of planets, the Sun and Moon included. In each of them one sees collected representations of the same planet from various Egyptian zodiacs, which gives us the opportunity to compare them with ease.

In order to distinguish between the cases of the first type, when the planet has been identified a priori, and those of the second type, for which the final identification was chosen out of several options, we

shall use the following approach. In the first case, the circle that contains the zodiac where the figure in question comes from shall look normal, and in the second case it shall be shaded grey. Thus, the grey shading of a circle refers to the fact that this figure's finite identification resulted from a calculation that involved all of the identification options.

We shall begin with Saturn.

4.2. Saturn in the primary horoscope

The "ancient" Egyptian symbols of Saturn from various Egyptian zodiacs are presented in fig. 15.31. Let us remind the reader that we shall only cover the symbols of the primary horoscope so far. Fig. 15.31 is divided into cells; each one of those corresponds to one Egyptian zodiac or another. The actual zodiac is represented by the circle one sees in the cell. If the circle has a grey shading, the figure of Saturn for this zodiac was identified after calculations involving different interpretation options. In other cases, the planetary symbol was identified as such during the preliminary analysis of the zodiac.

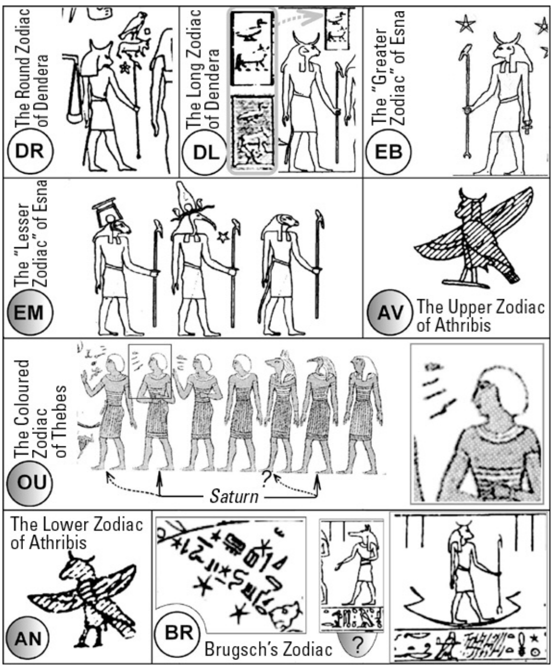


Fig. 15.31. Saturn in the primary horoscope as drawn in various Egyptian zodiacs. Cells where the circles with the horoscope codes are shaded grey refer to cases where Saturn could not be identified reliably in the preliminary analysis stage, and its identification would only become clear after astronomical calculations accounting for all possible variants. The zodiacs of Petosiris aren't represented. Fragments taken from [1100], [1062] and [544], Volume 6.

We see no drawings from the zodiacs of Petosiris in fig. 15.31. The matter is that Saturn, likewise a number of other planets, is drawn in a manner most peculiar for Egyptian astronomical symbolism – as waist-long portraits, which resemble each other to a great extent in case of Saturn and Jupiter. None of the two possess the distinctive characteristics of Jupiter and Saturn as seen in other Egyptian zodiacs. Therefore, the problem of their planetary identity had to be solved via sorting through all possible options and involved a large body of astronomical calculations. In general, these drawings are of little interest, and stand apart from all other Egyptian representations of Jupiter and Saturn. We shall deal with them further on.

One has to mention some of the idiosyncrasies inherent in Brugsch's zodiac in re fig. 15.31. Pay attention to the fact that one sees three pictures of Saturn in this zodiac (cell BR in fig. 15.31). This results from the fact that Brugsch's zodiac contains three primary horoscopes at the same time, as we mentioned above. In the horoscope that was dated by N. A. Morozov, the name of Saturn is a demotic subscript (*ibid*). In the other two, discovered by the authors of the present book, Saturn is presented as figures.

The history of the discovery of all three horoscopes from Brugsch's zodiac was told above. Let us relate it in brief – the demotic subscript horoscope had been discovered by Brugsch himself as early as in the XIX century. Brugsh found a coffin with a zodiac in Egypt and published its description accompanied by a drawn copy in 1862 ([1054] and [544], Volume 6, pages 694-697). In particular, Brugsch noticed a number of subscripts in Egyptian demotic writing. One sees them between the constellation figures to the left from the central figure of "the goddess Nuit", qv in figs. 12.17 and 13.14. When Brugsh had read all of the subscripts, it turned out that they contained the names of all the planets except for the Sun and the Moon, whose positions were also given explicitly nonetheless. This resulted in the compilation of a complete horoscope that we shall be referring to as the "demotic subscript horoscope" from Brugsch's zodiac.

Recently we made the discovery of two more horoscopes in Brugsch's zodiac. Unlike the demotic horoscope, as discovered by Brugsch and dated by Morozov, they aren't subscripts, but consider an integral part of the actual zodiac. The planetary figures thereupon stand in boats, hence the name "horoscope with boats". Planetary figures of yet another zodiac are drawn without rods, possibly in order distinguish them from the zodiac with boats, qv in fig. 13.17. We refer to it as to the "horoscope without rods".

Let us return to the drawing with the Egyptian drawings of Saturn (fig. 15.31).

The figure of Saturn is easy to recognize in the Egyptian zodiacs, since it possesses some distinctive traits, one of those being a crescent on the head of the figure. As a rule, a planetary figure from an Egyptian zodiac with a crescent on its head is Saturn. Another Egyptian attribute of Saturn is a hieroglyph of an ox or a bull near the head of the figure. In cases when one finds said attributes in a horoscope, it is easy enough to identify Saturn, and there is no confusion in the researcher camp (see [544], Volume 6, for instance, as well as [1062] and [1062:1]. In other cases we must choose from a variety of options. Let us linger on this for a while and explain why Saturn's representations in the Egyptian zodiacs are usually similar to what one sees in fig. 15.31.

In fig. 15.31 the circles standing for zodiacs aren't shaded grey in four cases out of seven, which means that in four cases the figure of Saturn had been identified as such prior to the astronomical calculations. Its position in the zodiac would subsequently be considered quite unambiguous. We shall begin with these simpler cases. The three other cases are presented in fig. 15.31 in the cells where the circles are shaded grey. These are more complex and required a choice from multiple possibilities. We shall deal with these cases below, in the sections related to the dating of individual zodiacs.

Let us study fig. 15.31 and see how Saturn is drawn in the zodiacs whose icons aren't shaded, starting with the large zodiacs from temples. The icons used for three of them aren't shaded in fig. 15.31. Those are the Round Zodiac of Dendera (DR), the Long Zodiac of Dendera (DL) and the zodiac from the Greater Temple of Esna (EB), qv in figs. 13.7, 12.13 and 12.14. In each of those we see virtually the same symbol with a planetary rod – a male figure with the face of an animal and a crescent on its head, qv in fig. 15.31.

We are using the word "crescent" – however, one could argue about the object in question being crescent-shaped horns rather than a crescent per se. This is possible. The shape of the figure with a crescent on its head does resemble the snout of a bull (*ibid*). However, we shall simply be using the term "crescent" below. It has to be said that it is completely unimportant for astronomical dating whether or not the object in question is in fact a crescent.

Next to the planetary figures with crescents on their head we see the same hieroglyphic inscription in both zodiacs from Dendera, which looks by a bull underneath a bird, with a star at the very bottom of the composition, qv in fig. 15.31 (DR and DL). A propos, in the Round Zodiac one sees another small hieroglyph that looks like a small square. According to the Egyptologists, it stands for a room or some other confined space, as well as the sound P ([370], page 19). The translation of the entire inscription as given in [1062] runs as "*Horus le taureau*" – Horus the bull, or Horus the Taurus. We aren't concerned with a precise translation at the moment; the important fact is that the repetition of the same description near two identical figures clearly attests to the fact that the figures in question refer to the same object, which is obviously a planet in this case and not some other astronomical figure – this is confirmed by the rods in the hands of the figures under study, qv in fig. 15.31.

What planet could this be? The answer had already been given in the works of our predecessors. The planet in question is Saturn ([544], Volume 6; also [912:3], [1062] and [1062:1]. In order to make the answer more clear, let us draw the reader's attention to the fact that near the planetary figure with a crescent on its head we see another similar figure in the Round Zodiac, also with a crescent on the top of its head; however, it is a scythe and not a rod that it's holding in its hands, qv in fig. 14.19 above. As we already mentioned, the second figure pertains to one of the secondary horoscopes, and a rod isn't an obligatory attribute in its case, although it does indeed represent a planet. All the planets of the main horoscope have rods in the Round Zodiac, which isn't always the case with secondary horoscopes. If we are to disregard the rod vs. scythe in the hands of the fig-

Fig. 15.32. Ancient drawing of the planet Saturn with a scythe from a mediaeval astronomical book allegedly dating from 1489 (Leupoldus de Austria, ***Compilatio de Astrorum Scientia*** – see [1247]). We see the legend *"Saturnus"* right next to the picture, quite obviously standing for "Saturn".
As we can see, the scythe, which used to symbolise death in ancient mythology and astronomy, had been an attribute of Saturn. Taken from [912:3], page 657.

ures, they resemble each other to such an extent that one can have no doubts about them standing for the same planet.

One must finally note that the scythe carried by the second figure is a well-known mediaeval symbol of Saturn. The scythe, which used to be a figure of death in mediaeval symbolism, is frequently found to be an attribute of the planet Saturn, qv in the pictures of Saturn taken from mediaeval European tractates on astronomy reproduced in [912:3], page 657. We reproduce one of such drawings in fig. 15.32. We see Saturn hold a scythe; thus, the figure with the scythe on the Round Zodiac is also most likely to represent the planet Saturn, qv in fig. 14.19. Thus, the second figure that we see hold a planetary rod in the Round Zodiac is also most likely to stand for the planet Saturn, qv in fig. 15.31 (DR). Let us point out that a perfectly similar figure represents Saturn in the Long Zodiac of Dendera (DL) and the "Greater" Zodiac of Esna (EB).

Thus, a male planetary figure with a crescent on its head is a representation of Saturn.

Coming back to the scythe in the hands of Saturn, one must point out that the latter used to be considered a "sinister planet" in general ([532], page 488). Furthermore, in the "ancient" mythology Saturn was identified as Kronos, the devourer of his own offspring ([532], page 488; also [1062], page 31). In other myths Saturn was considered the Lord of the Dead ([532], page 488). We already mentioned the scythe to be a symbol of death. No other planet out of the six known in antiquity possesses such "deathly" qualities. Therefore, we consider the idea that the scythe in the hands of the figure from the Round Zodiac of Dendera as voiced by N. A. Morozov and other researchers to be perfectly sound.

In general, there was no controversy involving the identification of Saturn on the Round Zodiac of Dendera. The very same figure that one can see in fig. 15.31 (DR) is identified as Saturn by both N. A. Morozov ([544], Volume 6) and Sylvia Cauville, a modern Egyptologist ([1062] and [1062:1]). A similar identification is suggested in the recent work by T. N. Fomenko ([METH3]:3, Chapter 12). As a result of our analysis, the abovementioned identification of Saturn receives additional validation, since the astronomical solutions that we have discovered (based upon the identification in question, among other things) are in perfect concurrence with all the graphical information one finds in the Egyptian zodiacs.

Let us now consider several more zodiacs from Egypt.

In the Ahtribean zodiacs of Flinders Petrie, Saturn looks like a bird with a crescent on its head, qv in fig. 15.31 (AN and AV). This identification results from a calculation that involves all possibilities (the circles for AN and AV are shaded grey in fig. 15.31). It corresponds with the identification of Saturn suggested for these zodiacs by the Egyptologists in [544], Volume 6, page 731. We must emphasize that N. A. Morozov had used a different identification here – an erroneous one, as it turns out ([544], Volume 6, page 738). See details below, in the section related to the dating of the zodiacs from Athribis.

Another zodiac with an unshaded circle in fig. 15.31 is the zodiac of Brugsch (BR). The figure of Saturn is easy to identify before the calculations. The actual zodiac of Brugsch can be seen in fig. 12.17 above. As we already mentioned, it contains three primary horoscopes at once – the "demotic subscript horoscope", the "horoscope with boats" and the "horo-

Fig. 15.33. A fragment of the "horoscope without rods" from Brugsch's zodiac. The four male figures refer to four planets following one another. Venus is absent, since it was always drawn as a female figure. Therefore, the four figures must be Mercury, Saturn, Jupiter and Mars. Our calculations yielded the following identifications of the four figures. From left to right: Mercury (with a human head), Jupiter (probably with a baboon's head), Saturn (with the head of a jackal) and Mars (with the head of a falcon). Fragment of a drawn copy from [544], Volume 6, page 696.

scope without rods". In fig. 15.31 (BR) one sees the figures associated with Saturn in each of the three horoscopes.

In the demotic subscript horoscope the name of Saturn, as well as that of Jupiter, is found in the two lines of text directed towards the head of Leo, qv in fig. 15.31 (BR). H. Brugsch interpreted the inscription a "Hor-pe-Setah" and "Hor-pe-Kah" ([544], Volume 6, page 697). Thus, Saturn isn't drawn as a figure in the horoscope in question, but rather represented by a simple inscription in the necessary place. This is a fortunate enough case; if the name of a planet is specified in a zodiac explicitly, one has no problems with identifying it.

In another horoscope that we find in Brugsch's zodiac – the "horoscope with boats", it is also easy to find Saturn, who is represented by exactly the same figure as we see in the zodiacs from Dendera (DR and DL), likewise the "Greater Zodiac" of Esna (EB). It is the figure with the body of a man and the head of an animal who stands in a boat with a planetary rod in his hand and a crescent crowning his head, qv in fig. 15.31 (BR).

As for the last horoscope of the zodiac, or "the horoscope without rods" that one finds on the vertical strip to the left of "the goddess Nuit", qv in fig. 13.17, the situation with identifying Saturn is somewhat more complex, hence the question mark under the presumed figure of Saturn in the horoscope, qv in fig. 15.31 (BR). The matter is that one doesn't know a priori which of the four male figures of the "horoscope without rods" represents Saturn (see fig. 15.33). There are four male figures in a row, with the respective heads of a jackal, a human, an ape and a falcon.

The situation is far from easy. However, we are fortunate since all four male figures are located near each other in the horoscope, qv in fig. 13.17. Since all of them are male, we can be certain about the fact that they represent Saturn, Jupiter, Mercury and Mars. The remaining three planets don't fit since Venus is represented by a female figure, whereas the Sun and the Moon aren't drawn as human figures at all, as is the case in most other Egyptian zodiacs. We shall discuss their symbolism below. Therefore, from the point of view of astronomical dating the exact identity of each of the four adjacent figures in the horoscope under study is of minor importance – what does matter is the fact that we know the identity of the entire set. Furthermore, astronomical calculations shall eventually enable us to perform the "casting" of the four figures correctly and learn which planet each one of them stands for (see fig. 15.33).

We shall provide a more detail account of this problem below, in the section concerned with the dating of Brugsch's zodiac. Let us simply cite the final solution here. Saturn is represented by the figure with a jackal's head in the present zodiac, qv in fig. 15.31 (BR) and fig. 15.33.

By the way, we should also point out the fact that the abovementioned four symbols of "male" planets in the Egyptian astral symbolism, or the figures with the head of a human, an ape, a jackal and a hawk weren't restricted to the Egyptian zodiacs; they were also used in the preparation of the Egyptian mummies. Egyptologists are of the opinion that these symbols referred to "the four spirits of the netherworld" ([2], page 14). This doesn't contradict our planetary identification of said figures since, according to the ancient beliefs, the souls of the deceased kings – Egyptian as well as Assyrian, which our reconstruction identifies as the same people, the founders of the Great Empire in the Middle Ages, would transform into stars after their death ([503], page 195; also [514:1], page 40). Furthermore, the names of the first

kings had at the same time served as the names of the "wandering stars", or planets ([503], page 195, [514:1], page 40 and [477:1], page 8. However, modern Egyptologists concur with the opinion of Parker and Neugebauer ([1290:1], Volume 1, pages 24-25) that the tradition that tells about souls transforming into stars really refers to the constellation of Orion and not the planets ([114:1], page 96). However, we shall demonstrate below that this erroneous opinion held by the Egyptologists results from their misinterpretation of the Egyptian sign for summer solstice, which they have misidentified as the constellation of Orion.

Let us quote what N. A. Morozov has got to say in this respect: "The seven divine rulers of the first Archaean dynasty [which is how N. A. Morozov refers to the First Dynasty of Egypt – Auth.] correspond to the seven ancient planetary deities. However, they didn't just rule over the valley of the Nile, but other ancient lands as well" ([544], Volume 6, page 786). We agree with N. A. Morozov in general – however, his mistake is that the chronology he uses is the one that he didn't manage to correct in its fullness, and it still contains errors. According to our reconstructions, it isn't the "ancient lands" of the IV-VII century A.D. that one should refer to, but rather the relatively recent history of the XIV-XV century A.D. ([REC]:1).

We shall now return to the four symbols of the "male planets" in Brugsch's "horoscope without rods" (BR) – the human, the jackal, the hawk and the baboon, qv in fig. 15.33. We have witnessed the use of these symbols in the manufacture of mummies. It is presumed that Egyptian mummies were made in the following order: "the entrails would be treated with boiling bitumen together with the liver and the brain, and sealed in special vessels made of clay, limestone or alabaster, as well as stone and metal (depending on the social standing of the deceased). Figures of four different heads would seal the tops of these urns, which would be put in the same sarcophagus as the mummy, representing the four spirits of the Otherworld – a human's, a jackal's, a hawk's and a baboon's" ([2], page 14). However, the same symbols could stand for the four planets – Mercury (human head), Saturn (jackal's head), Mars (hawk's head) and Jupiter (baboon's head). If these planets were identified as the souls of the first kings of the Great "Mongolian" Empire, or the kings of the new epoch of the XIV-XV century, according to the New Chronology ([REC]:1), using planetary symbols in the funereal rites of the subsequent rulers of the Empire is an obvious thing to do.

Saturday, or the sixth day of the week that began with Sunday, was associated with Saturn. *Dies Saturni*, the Latin name of the day, literally means "Saturn's day" ([393], page 41).

4.3. Seth, Anubis and Thoth as the symbols of Saturn and Mercury

Identifying Saturn as the figure with a jackal's head is also logical from the point of view of the Egyptian mythology. It is presumed that a jackal's head in the Egyptian drawings stood for "the god Anubis" ([370], page 15). The ***Dictionary of Mythology*** tells us that "Anubis (Greek), or Inpu (Egyptian) is the god of the dead in Egyptian mythology; was revered in the form of a lying jackal, black in colour, or Sab, the wild dog, or a human with the head of a dog or a jackal … according to the ***Pyramid Texts,*** Anubis had been the principal deity of the Netherworld ([532], page 49). Saturn was also considered the god of the dead ([532], page 488). This was often emphasized in the Egyptian drawings of the planet Saturn, as we witnessed above. See also [METH3]:3, Chapter 12, page 657, and fig. 15.32 as cited above.

On the other hand, it is presumed that the Egyptian "god Anubis" would be associated with Hermes by the Greeks, and the latter, in turn, was a double of the Roman Mercury ([532], pages 50 and 151). Thus, Anubis could stand for Mercury as well as Saturn, which is a possibility that we accounted for in our research of the Egyptian zodiacs.

Our calculations demonstrated that the jackal's head can indeed correspond to both Saturn and Mercury in Egyptian symbolism. For instance, in the "Greater Zodiac" of Esna the figure of Mercury has the head of a jackal. It is most likely that Mercury has the head of a jackal in the "Theban coloured zodiac" (OU), where Saturn has the head of an ibis, qv in fig. 15.31 (OU). However, one needs to point out that in the latter case Saturn and Mercury prove to be very close to each other, according to our astronomical solution – which is what one also sees in the zodiac. Thus, astronomical calculations cannot help with the "role

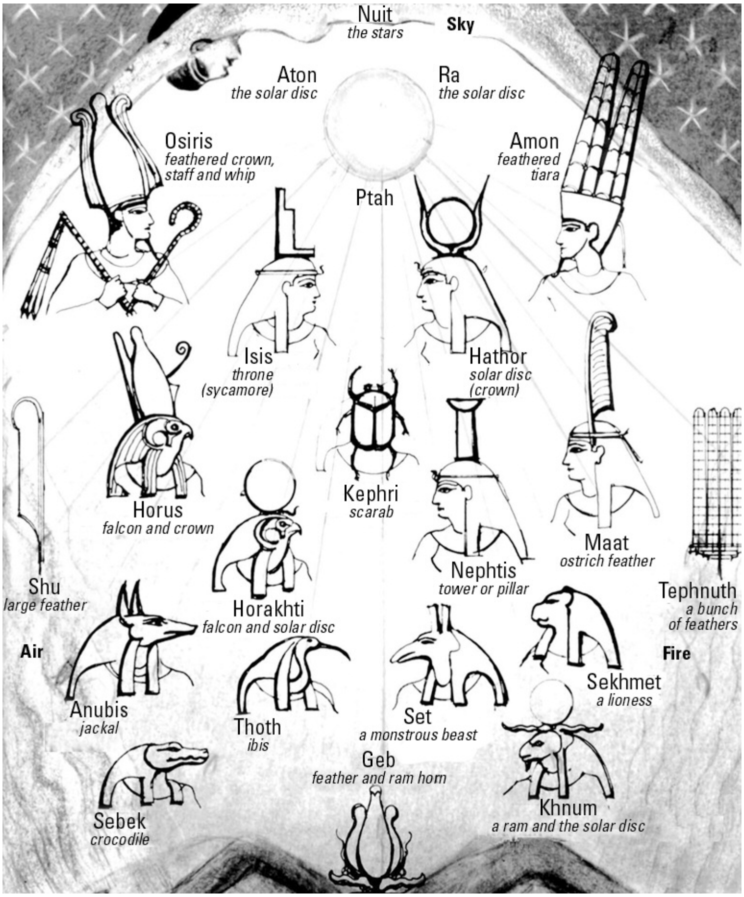


Fig. 15.34. Egyptian "deities". Many of these symbols were used for referring to planets in ancient Egyptian symbolism. Taken from [370], page 15.

distribution" between the symbols of Saturn and Mercury in the OU zodiac, qv in fig. 15.31 (OU) and fig. 15.45 (OU) below.

However, the head of a jackal used as a symbol of Mercury on an Egyptian zodiac in an exception rather than the rule. We have discovered that Mercury would most often be drawn with a human face (if his figure possesses two faces, one of them is human, at least). We shall cover Mercury in detail below.

Thus, the issue of identifying the wayfarer with a jackal's head as a planet could be solved in a variety of ways. Let us linger on this for a while.

N. A. Morozov, in his account of the drawings from the Round Zodiac of Dendera, tells us that the Egyptian Anubis with the head of a jackal used to symbolize Saturn ([544], Volume 6, pages 653, 658 and 678). Morozov's concept was correct in general. However, in the Round Zodiac that Morozov tells us of in the present case, Saturn has the head of a bull and not a jackal. It is clearly visible if one is to use higher-quality renderings of the Round Zodiac than the one that Morozov had at his disposal (see fig. 15.31 (DR), as well as the illustrations cited above – figs. 12.30 and 12.31. The jackal's snout in Egyptian drawings would usually be a great deal more oblong than that of Saturn from the Round Zodiac (see the drawing with Anubis with the head of a jackal in fig. 14.7, for instance.

The ***Dictionary of Mythology***, on the other hand, claims that the Egyptian Anubis corresponded to Mercury and not Saturn, qv above.

This confusion might be partially explained by the following fact. It appears that there was another "god" in the "ancient" Egyptian patheon, who was all but indistinguishable from Anubis in appearance. It is Seth (or Set), the "god of destruction" ([370], page 14), the "epitome of evil and the murderer of Osiris" ([532], page 496). Seth would also be drawn with a planetary rod in his hands, qv in fig. 14.7, and therefore corresponded to some planet. His "sinister" qualities fit Saturn perfectly, and the names of the two resemble each other.

We already cited the picture of the "Egyptian god" Seth above in fig. 14.7. Another picture of Seth and also Anubis can be seen in fig. 15.34. In both illustrations one sees that the Egyptian drawings of Anubis and Seth are near-identical. Anubis has the head of a jackal, and Seth's head looks very similar, qv in figs. 14.7 and 15.34. It is possible that in order to make this similarity with Anubis less obvious, the Egyptologists evasively refer to Seth's head as to that of a "monster" ([370], page 15). The Egyptians apparently drew a monster unknown to science, and our learned scholars neither know what animal it might resemble, nor want to. However, the heads of all other Egyptian "gods" belong to actual animals and not fantasy "monsters" – see fig. 14.7, for instance.

Set is most likely to be Saturn with the head of a jackal, whereas Anubis is Mercury, also with the head of a jackal. Hence the similar heads and different names of these "Egyptian deities" – they stand for different planets. One and the same Egyptian figure with the head of a jackal is referred to as wither Anubis or Thoth, which depends of the inscription seen next to it.

However, this implies that the same symbol (a male figure with the head of a jackal) could be used in the "ancient" Egypt for referring to Saturn as well as Mercury. This indeed appears to have been the case.

Jackal's head is not the only symbol that could be used for both Saturn and Mercury. The head of ibis is another example.

The name of the "ancient" Egyptian god with the head of an ibis is Thoth. His drawings can be seen in figs. 14.7 and 15.34. It is presumed that the Egyptian Thoth, or ibis, corresponded to the Greek Hermes, or Mercury. "Living ibises were a symbol of Thoth – the Greek Hermes; they would be mummified after death and kept in vessels of clay", according to the descriptions of the "ancient" Egyptian rites ([2], page 12). Thus, according to the Egyptologists, Thoth can be identified as Mercury.

However, it turns out that in some cases Thoth, or the ibis, would stand for Saturn and not Mercury in the Egyptian zodiacs. See the drawing of Saturn from the Lesser Zodiac of Esna, for instance (EM), fig. 15.31 (EM), that we discovered as a result of astronomical calculations. It turns out that Saturn is represented by a procession of three male wayfarer figures carrying planetary rods, qv in fig. 15.31 (EM). The two figures on the sides have ovine heads, while the one in the middle has the head of an ibis. Thus, we see Saturn drawn with the head of an ibis (and also that of a ram). We also see Saturn drawn with the head of an ibis in the "coloured zodiac" of Thebes, qv in fig. 15.31 (OU). This concurs well with the fact that, according to a number of researchers, Thoth and Seth used to be two names of the same "ancient Egyptian god" ([1335:1], quotation given according to [1099:1], II, pages 78-80).

4.4. Confusion between Saturn and Mercury in astral symbolism

Such ambiguity with the Egyptian Anubis/Seth (jackal) and Thoth (ibis), which could stand for Mercury and Saturn, would invariably result in some confusion between the two in the ancient astral symbolism. Would any traces of this confusion survive? Apparently, some of them have, which was pointed out by N. A. Morozov. He writes that "Seth is considered the oldest son of Osiris and the murderer of the latter; he is the lord of darkness. Astrologically he is represented by … Mercury, who always hides behind the Sun, as if lying in ambush from whence he slays his father, the Moon, or Osiris, when the latter approaches the Sun … later on, when the evil qualities became a prerogative of Saturn, he would become confused with the latter" ([544], Volume 6, page 787).

Morozov is most likely to be right here. It is likely that Saturn hadn't always been the "sinister planet" or the "god of the dead". This happened later, in which case the Egyptian zodiacs where Saturn has the full attributes of a "sinister" figure – the deathly scythe et al, aren't quite as "ancient" as we're told. It is easy to

understand why the astronomical dates of the Egyptian zodiacs that have reached our day keep turning out mediaeval.

4.5. Our hypothesis in re the genesis of the old cult of Saturn

We have to make the following statement in re the original cult of Saturn. It bears no direct relation to the problem of astronomical dating, but is useful for the understanding of the resulting datings of the Egyptian zodiacs.

According to our reconstruction, all of the "ancient" myths about the "Olympian gods and goddesses" date to the epoch of the Great = "Mongolian" conquest of the XIV century. This was the epoch when the Great Empire was created. The "ancient" myths date to a later epoch; they are embellished biographical episodes concerning the real first rulers of the Great Empire, whose zone of influence had covered the European "antiquity zones" for a long time, in particular. The rulers of the Empire had taken their court to an area that was at a great distance from Europe in the XIV century – the Vladimir and Suzdal Russia. Thus, the Western Europeans, as well as other imperial subjects from areas located at some distance from the East, would think of the rulers as "faraway and inaccessible gods". Local tales of the faraway kings would eventually attain fairy tale hues and reached our day as the very same myths that historians declare to be "extremely ancient" nowadays.

According to our reconstruction, the deceased kings of the Empire would be brought to the Nile Valley in Egypt for their burial. Thus, we are of the opinion that Egypt used to serve as a gigantic imperial royal cemetery. Thus, the monuments of the "ancient" Egypt weren't serving local ends, but rather those of the gigantic Empire that included Egypt as its tiny part. They were constructed with the collective imperial resources used for the purpose, and not just the Egyptian ones. Hence the mind-boggling scale of the "ancient" Egyptian sepulchral architecture, qv in Chron5.

According to our reconstruction, one of the founders of the Great Empire had been Great Prince Ivan Danilovich Kalita, also known as Batu-Khan (possibly a form of "Batya", or "father"), who had colonized Western Europe during his "occidental campaign". It turns out that in the "ancient" Greek myths Ivan Kalita (Kaliph) became known as the god Kronos, or the planet Saturn in astral symbolism. His heir was the Great Prince Simon the Proud who was known as Dy, Zeus and Jupiter in the "ancient" mythology. He was identified with the planet Jupiter in mediaeval astral symbolism, qv in [REC]:1.

Thus, the "ancient" myths of Kronos (Saturn) are the biographical accounts of the Great Prince Ivan Danilovich Kalita, the colonizer of the Western Europe. They remained oral tradition for a long time, and started to look like a fairy tale. Let us quote the respective passage from the ***Dictionary of Mythology:***

"The ideas of Kronos resulted in Saturn (whatever his initial functions had been) revered as the god of the Golden Age, one of the first Latian kings [Latius or Ratius is yet another name of Russia – Auth.] where, according to a version of this myth, he had escaped to, deposed by his son Jupiter. He was accepted warmly by Janus [Ivan – Auth.] who had ruled there and shared the power with him" ([532], page 488).

"Set, Seth or Suthekh is the "god of foreign lands" in Egyptian mythology … a figure that represents the forces of evil … Seth was revered alongside Horus as the protector of royal power, which is reflected in the ***Pyramid Texts*** and the titles of pharaohs of the II dynasty (the combination of the names of Seth and Horus yields "Czar"). Under the Hyxos [Cossack – Auth.] rule, Seth was identified as Balu [or the White King – Auth.]. One encounters many names with "Seti" a part of them in the beginning of the New Kingdom; these names were borne by the pharaohs of the XIX dynasty – Seti, Sethnakht et al. Seth used to called "the mighty" … in the period of the Old Kingdom Seth was credited with saving Ra from the serpent Apop, whom he had run through with his harpoon" ([532], page 496).

A propos, according to our reconstruction, it is this very "victory over the serpent" that one would see in the famous Russian icons as "the Miracle of George and the Serpent" with St. George piercing the serpent with his spear. Let us remind the reader that, according to our reconstruction, St. George is the older brother of Ivan Kalita, the Great Muscovite Prince George, also known as Genghis-Khan, the creator of the Great = "Mongolian" Empire, qv in Chron4. It

is possible that in the Egyptian astral symbolism the two great princely brothers were represented by Mercury and Saturn, and the two-faced Janus (Ivan) in the "Roman pantheon". We shall discuss it in more detail below, in our account of the Egyptian symbolism of Mercury. The only thing we shall point out here is that the confusion between the symbols of Mercury and Saturn was due to the later merging of the two brother's images.

Let us carry on quoting from the ***Dictionary of Mythology:***

"The names of the holy animals associated with Seth would often include such epithets as "the tempest" or "the hurricane" … Seth would also occasionally be called Apope [Pope? – Auth.]" ([532], page 496).

4.6. Jupiter in the main horoscope

Drawings of Jupiter from the primary horoscope as encountered in Egyptian zodiacs can be seen in fig. 15.35. Fig. 15.35 is divided into cells; each of those corresponds to a single zodiac. The zodiac's abbreviation can be seen in the circle inside the cell. If the circle is shaded grey, the discovery of Jupiter for the zodiac in question was made as a result of calculations involving different identification options. Otherwise it was discovered during the preliminary stage of zodiac analysis.

There are no drawings from the zodiacs of Petosiris in fig. 15.35. We have explained the reasons for this above. We shall deal with Jupiter as drawn in the zodiacs of Petosiris below.

As is the case with Saturn, we see three different pictures of Jupiter in fig. 15.35 (Brugsch's zodiac, cell BR in fig. 15.31). This results from the fact that there are three primary horoscopes in Brugsch's zodiac and not one – the "demotic horoscope", the "horoscope without rods" and the "horoscope with boats", qv above. In the first one we see Jupiter's name in demotic script, qv in fig. 15.35 (BR), whereas he's presented as human figures in the two others.

In both the Round and the Long Zodiacs of Dendera Jupiter has got the same hieroglyphic subscript that looks like a bird over a long pair of horns with a circle inside, qv in fig. 15.35 (DR and DL). This is the inscription that Brugsch used to identify Jupiter in the zodiacs of Dendera. He interpreted it as "Hor-Apis-Seta", which, according to Brugsch, stands for "Planet Jupiter" ([544], Volume 6, page 652). Brugsch's opinion in re Jupiter in the zodiacs of Dendera did not lead to any objections from the part of N. A. Morozov, who had accepted it instantly (*ibid*). T. N. Fomenko adheres to the same identification in [912:3], pages 652 and 700. Modern Egyptologists identify Jupiter as drawn in the Dendera zodiacs in the exact same manner ([1062], page 31). Thus, all researchers of the zodiacs from Dendera were of the same opinion in re identifying Jupiter according to Brugsch.

We also followed the identification of Jupiter suggested by H. Brugsch, which is reflected in the fact that both of the circles representing the Dendera Zodiacs (DR and DL) aren't shaded grey in fig 15.35, which, as we agreed above, means that the planetary figure had been identified in the zodiac beforehand quite unambiguously.

One could naturally doubt Brugsch's interpretation of the hieroglyphic inscription in question, especially seeing how S. Cauville, a modern Egyptologist, reads these hieroglyphs from the Round Zodiac of Dendera in an altogether different manner, for some reason, suggesting two different interpretations thereof – "Horus who makes the land bright (with a lightning?)", or "Horus qui éclaire le pays", and "Horus, the god of mystery", or "Horus qui devoile le mystère" ([1062], page 31). Nevertheless, S. Cauville also identifies the figure in question as Jupiter – possibly, due to the fact that Jupiter cast bolts of thunder and lightning over the land, "making it bright" after a manner.

Without going into further details concerning the translation of hieroglyphic inscriptions, we should point out that this identification of Jupiter was in fact confirmed by our study of the Egyptian zodiacs. Solutions based on the planet in question (as well as other planets) ideally correspond with the whole body of astronomical information that we have found in the Egyptian zodiacs. At the same time, no deviations from planetary identifications can lead to ideal solutions, as our experiment demonstrates (at least, such is the case with zodiacs rich in content, like both of the Dendera zodiacs).

The hieroglyph that looks like a pair of horns with a circle inside would also be drawn as a hat or a detail of Jupiter's headdress. This fact was discovered by

the authors in the course of their study of the zodiacs. For instance, in the Greater Zodiac of Esna (EB) we see a pair of curved horns on the head of the last figure in Jupiter's procession with a circle between them, qv in fig. 15.35 (EB). Let us point out that the drawing of Jupiter in the EB zodiac hadn't been identified in advance – it took sorting through all possible options and extensive astronomical calculations. See more details on how it was done in the section on the dating of the EB zodiac. In fig. 15.35 (EB) we only cite the final result of identifying Jupiter on the zodiac. A magnified drawing of Jupiter from the EB zodiac can be seen in fig. 15.36.

It turned out to correspond with the respective figures of Jupiter from the Dendera zodiacs, although this hadn't been obvious initially due to the fact that the shape of horns on the last figure in Jupiter's procession in the EB zodiac differs from that of the horn-shaped hieroglyph from the Dendera zodiacs. In the Dendera zodiacs the hieroglyph horns are stretched upwards with a characteristic curve, whereas in the "Greater Zodiac of Esna" they are turned sideways in such a way that they form a straight line, qv in fig. 15.25 (DR, DL and EB). Nevertheless, the symbol appears to be one and the same – a circle between the horns.

By the way, if we are to take a closer look, we shall see that similar undulated horns crown the head of Jupiter on the Long Zodiac of Dendera as well. They are complemented by two cobras and a tall hat, which precludes us from observing the similarity with the headdress from zodiac EB. Nevertheless, once observed, the similarity becomes obvious, qv in fig. 15.35 (DL and EB).

The circle between the horns as a part of Jupiter's headdress can also be seen in the procession that depicts Jupiter in the Lesser Zodiac of Esna (EM, in fig. 15.35). Let us pay attention to the headdress worn by the third and the seventh (last) figure in the procession. It comprises both kinds of horns with a circle that we have referred to above. The wide undulated horns with a circle on top comprise the lower part of the headdress, whereas the vertical horns with a circle of their own top it, qv in fig. 15.35 (EM).

Thus, a pair of horns with a circle in the middle is a frequently-encountered attribute of Jupiter in the Egyptian astronomical symbolism.

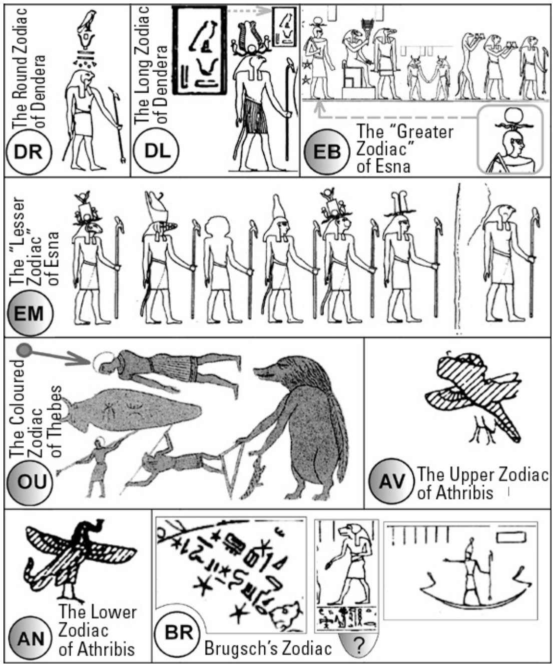


Fig. 15.35. Jupiter in the primary horoscope of various Egyptian zodiacs. Cells with grey circles refer to calculated identification of the planet with all possible versions taken into account. The spring equinox symbol in cell EB, which wound up inside the Jupiter procession, was deliberately made smaller for better representation. The zodiacs of Petosiris are not represented. Fragments taken from [1100], [1062] and [544], Volume 6.

Another zodiac for which we had identified Jupiter prior to the beginning of calculations is the zodiac of Brugsch (excepting the "horoscope without rods", qv in fig. 15.35 (BR). Let us remind the reader that Brugsch's zodiac contains a total of three main horoscopes – the "demotic horoscope", the "horoscope without rods" and "the horoscope with boats". We already mentioned this above, and will address the issue at length in the section on the dating of Brugsch's horoscope.

In the "demotic horoscope" we see the name of Jupiter written next to that of Saturn in the two lines directed towards the head of Leo, qv in fig. 15.35 (BR). Brugsch interprets them as "Hor-pe-Setah" and "Hor-pe-Kah" ([544], Volume 6, page 697). He is of the opinion that they're the names of the planets Saturn and Jupiter. As is the case with Saturn, we shall

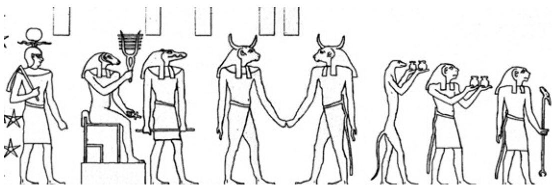


Fig. 15.36. Jupiter in the Greater Zodiac of Esna (EB). Jupiter is represented by the procession of figures that we see. A male figure is in front; the last figure in the procession is also male and has undulated horns turned sideways with a circle in the middle on its head. The procession also contains the spring equinox symbol that looks like two figures with crescents on their heads holding hands. This symbol has got nothing to do with Jupiter. Taken from [1100], A. Vol. I, Pl. 79.

trust Brugsch's translations, seeing as how there are no other planetary signs in the present horoscope except for the inscriptions with their names. Let us point out that we shall get a valid solution if we use Brugsch's translation – apparently, his translation is correct, or we would have come up with a meaningless answer.

In all the other zodiacs represented in fig. 15.35 Jupiter was found after sorting through a number of possible versions. We shall relate how it was done in each exact case below, in the sections dealing with the dating of the zodiacs.

Let us point out that in the zodiacs of Athribis Jupiter is drawn as a bird with the head and the tail of a serpent, which one sees quite well in the Lower Zodiac of Athribis (fig. 15.35 AN). In the Upper Zodiac of Athribis the bird that stands for Jupiter is in a very poor condition, the only part that didn't take much damage being one of the wings. It is therefore difficult to tell anything about how its tail and head are drawn, as one sees from fig. 15.35 (AV). However, judging by how all the other planets are drawn identical in both zodiacs of Athribis, one may suggest that this Jupiter bird also had a serpent's head and tail. Identifying Jupiter as the bird with the serpent's head concurs with the idea of the Egyptologists that Jupiter was drawn as a bird with a snake's tail ([544], Volume 6, page 731). However, we weren't taking this idea into account. Our identification had been purely formal and based on computer calculations involving different versions. See the chapter on the datings of the Athribis zodiacs for more details.

Jupiter ruled over Thursday, the fifth day of the week counting from Sunday. The Latin name of Thursday is *Dies Jovis,* or "the day of Jove (Jupiter)", qv in [393], page 41.

4.7. Mars in the primary horoscope

Drawings of Mars in the primary horoscopes of various zodiacs can be seen in fig. 15.37. Each of the drawing's cells corresponds to a single Egyptian zodiac, whose abbreviated name can be seen in the circle. If the circle in question is shaded grey, it means that Mars in the present zodiac was found through calculations involving a multitude of options. Alternatively, Mars had been found instantly, during the preliminary analysis.

Drawings of Mars from the zodiacs of Petosiris are missing from fig. 15.37. We shall discuss them below.

In fig. 15.37 one sees three different drawings of Mars from the zodiac of Brugsch (cell BR in fig. 15.37), since, as it has already been mentioned, we have discovered three primary zodiacs on the horoscope of Brugsch – the "demotic subscript horoscope", the "horoscope without rods" and the "horoscope with boats", qv above. In the first horoscope the name of Mars is written in demotic script. The inscription in question was read and translated by H. Brugsch, who had been the first one to study this zodiac. Brugsch's translation was used by N. A. Morozov as well. He writes that "near Virgo, closer to Leo, we see a demotic inscription saying Hor-Teser, or "the planet Mars" ([544], Volume 6, page 697). In the two other horoscopes from Brugsch's zodiac Mars is drawn as a male figure with the head of a falcon, qv in fig. 15.37 (BR).

As one sees from fig. 15.37, nearly all of the Egyptian drawings of Mars are similar – a male figure, usually on its own, with the head of a falcon. We find the EB zodiac (from the Greater Temple of Esna) and the Athribis zodiacs of Flinders Petrie to be the only exceptions. In the zodiacs of Athribis Mars is drawn as a bird with a long serpent-like tale. In the "Greater Zodiac of Esna", as we shall see below, there are no figures with falcon heads whatsoever. Here we see Mars as a man with a whip on his shoulder, holding a planetary rod, with a human face in this particular case, qv in fig. 15.37 (EB).

Identifying the lone male figure with the head of a falcon as Mars is a tradition that originates in Brugsch's interpretation of the hieroglyphic inscription found near this figure in the Long Zodiac of Dendera. Brugsch read it as "Hor-Tos" (Hor-Teser, or Hor-Tesher) and translated it as "the Red planet", or Mars, which is the only planet known for its red glow.

Such identification of Mars in the Long Zodiac of Dendera was subsequently accepted by N. A. Morozov and all the other researchers of the Dendera zodiacs. Respectively, a similar figure was chosen as the representation of Mars on the Round Zodiac of Dendera. Here we see it stand a little bit above Capricorn, almost on the back of the latter, qv in fig. 15.38. The uniformity of Martian symbolism in both zodiacs is also emphasised by the fact that in both hieroglyphic inscriptions we find over the heads of these characters on the two zodiacs we see the same bird-like symbol – a goose, or possibly an ibis, qv in fig. 15.37 (DR) and also in the photograph of Mars from the Round Zodiac of Dendera (fig. 15.38). In both illustrations one can plainly see the inscription over the head of Mars that consists of two hieroglyphs looking like different species of birds with stars below them. According to the translation made by the modern French Egyptologist S. Cauville, the present inscription identifies this figure from the Round Zodiac of Dendera as Mars.

We have adhered to this identification of Mars in the Zodiacs of Dendera from the very start, as one sees from fig. 15.37 (DR and DL). The circles with the indications of both Dendera zodiacs aren't shaded in fig. 15.37, which, as we have agreed above, means that the present planet had been identified unambiguously a priori, and we didn't take any other options into account. Let us emphasize that this only concerns the figures of Mars found in the Zodiacs of Dendera, Brugsch's zodiac and the "Coloured Theban" zodiac OU (see the unshaded circles in fig. 15.37 (DR, DL, OU and BR). Below we shall see that there were no other options for identifying Mars in these zodiacs. In all other cases presented in fig. 15.37 we have exhausted all possible identification options for Mars.

Tuesday is the day of the week that was governed over by Mars (the third day in a week counting from Sunday). The Latin name for Tuesday is *Dies Martis,* or "the day of March" ([393], page 41).

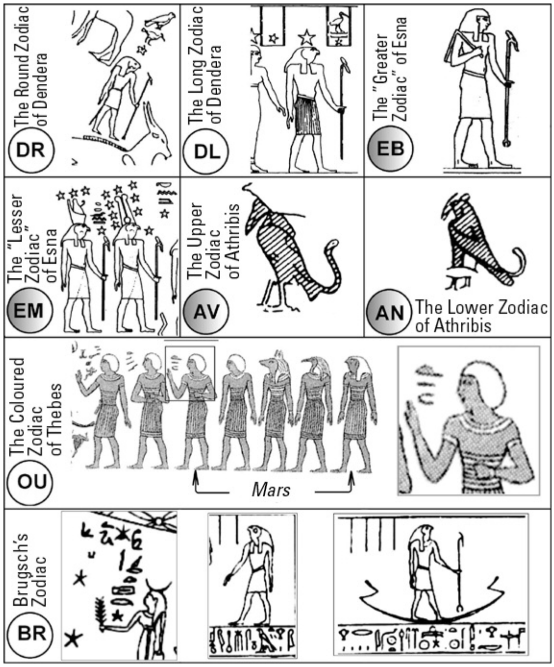


Fig. 15.37. Mars in the primary horoscope of various Egyptian zodiacs. Cells with grey circles refer to calculated identification of the planet with all possible versions taken into account. The zodiacs of Petosiris are not represented. Fragments taken from [1100], [1062] and [544], Volume 6.

Fig. 15.38. Mars in the primary horoscope of the Round Zodiac from Dendera (DR). From a modern photograph of the Round Zodiac kept in the Louvre (France). Taken from [1101], page 255.

4.8. Venus in the primary horoscope

Venus as represented in the primary horoscopes of various zodiacs can be seen in fig. 15.39. Each of the drawing's cells corresponds to a single zodiac whose abbreviation we see inside the circle. If the circle in question is shaded grey, Venus in the present zodiac was found after we exhausted every possible option in computations – otherwise, its identity was known to us a priori.

The drawings of Venus from the zodiacs of Petosiris aren't present in fig. 15.39. We shall mention them below.

Three different drawings of Venus are given for Brugsch's zodiac in fig. 15.39 (BR) – one for each of the three abovementioned primary horoscopes of the zodiac, namely, the "demotic zodiac", "zodiac without rods" and the "zodiac in boats". In the first the name of Venus was written in demotic script and written by Brugsch. N. A. Morozov, who had used Brugsch's translations in his research, describes the inscription as follows: "We see the demotic inscription Pe-Nether-Tau, or the Morning Star (Venus) between Scorpio and Sagittarius, curved towards the head of the latter" ([544], Volume 6, page 697). In the two other horoscopes from Brugsch's zodiac we see Venus represented as figures, qv in fig. 15.39 (BR). In one of them (the "horoscope with boats") the figure of Venus is easily recognizable. However, in the "horoscope without rods" Venus looks rather odd for the Egyptian astronomical tradition. However, some of the distinctive characteristics that we find in other Egyptian drawings of Venus are present here as well. We shall address it in more detail below.

In fig. 15.40 one sees a fragment of the EB zodiac from the Greater Temple of Esna. In particular, we see Venus as two figures bearing rods – the female figure followed by the male figure with a leonine head. In front of Venus we see Mars with a rod in his left hand and a whip in his right.

If one is to approach the search of Venus in the Egyptian zodiacs sensibly, it presents us with a minimal amount of problems as compared to all other planets (among the ones drawn as human figures in the Egyptian zodiacs). Indeed, Venus is the only female figure among all the planets. Let us remind the reader that Venus is always a woman in mythology ([532], page 121). Another "female planet" (the Moon) was usually drawn as a circle or a crescent – confusing it for Venus is therefore an impossibility. One would think it relatively easy to specify the location of Venus in the zodiac – it should suffice to find a female planetary figure to identify the planet without any uncertainty whatsoever, since there shall be just one female planetary figure in the Egyptian zodiacs, as we are about to witness. We shall thus identify it as Venus.

We have done just that in our research. Computer calculations demonstrated this approach to have been correct. N. A. Morozov, whose identification of Venus in the Zodiacs of Dendera has been meticulously verified by the authors and proven correct, had done the very same thing. Let us point out that the female figure from an Egyptian zodiac often has several additional characteristics that identify it as planet Venus. We shall discuss this in detail below.

However, Heinrich Brugsch, the famous Egyptolo-

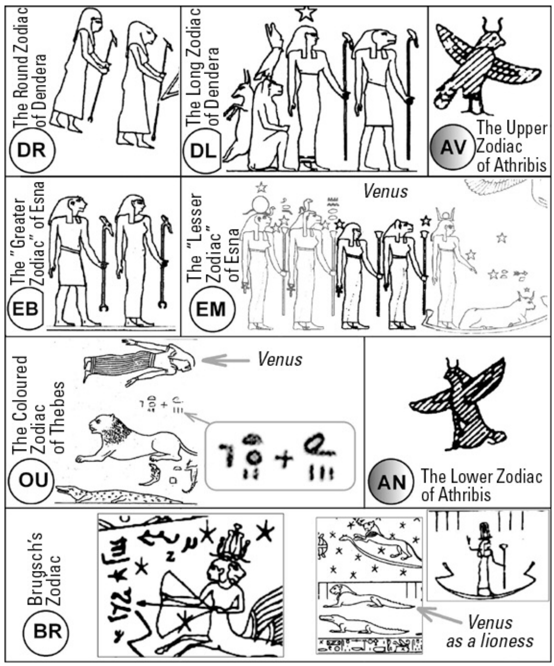


Fig. 15.39. Venus in the primary horoscope of various Egyptian zodiacs. Cells with grey circles refer to calculated identifications of the planet with all possible versions of identifying birds as planets taken into account. The zodiacs of Petosiris are not represented. Fragments taken from [1100], [1062] and [544], Volume 6.

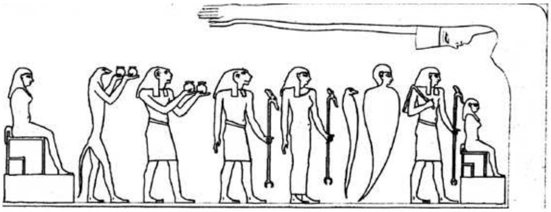


Fig. 15.40. Venus and Mars in the primary horoscope of the EB zodiac from the Greater Temple of Esna. Venus is drawn as two figures with rods – a female one followed by a male figure with a leonine head. In front of Venus we see Mars with a staff in his left hand and a whip in his right. Taken from [1100], A. Vol. I, Pl. 79.

gist of the XIX century, had made a grave mistake concerning Venus, which, odd as it would seem, one still comes across as it is copied from research to research and appears on the pages of books written on the subject of the Egyptian zodiacs to this day, qv in [1062], page 30, for instance. However, as early as in the first half of the XX century N. A. Morozov pointed out Brugsch's error and explicated the reasons for its existence well enough. Those are as follows.

When H. Brugsch was deciphering the astronomical content of the Round Zodiac of Dendera, trying to estimate the position of Venus thereupon, he had for some reason completely disregarded the symbol consisting of two wayfaring women side by side with planetary rods in their hands, qv in fig. 15.39 (DR). The reason for this might be the fact that this symbol wasn't signed in the Round Zodiac, while Brugsch was basing his planetary identifications on the interpretation of hieroglyphs for the most part. We see none of those next to the wayfaring women, which isn't the case with any other planetary symbols in the Round Zodiac, qv in fig. 15.39 (DR). Nevertheless, it is the only female planetary symbol in the entire Round Zodiac.

All of this notwithstanding, Brugsch didn't think of counting these female figures as planets. Instead, he suggested to use the male planetary figure with a double face, no less – the one that we see near Pisces in the Round Zodiac and in Aries in the Long Zodiac, qv in fig. 15.45 (DR and DL) below. Brugsch was motivating this by his interpretation of the hieroglyphic inscription that he had found near this figure in the Long Zodiac – namely, "god (or goddess) of the morning". Apparently, he had been of the opinion that this inscription might only stand for Venus, yet there is another astronomically valid version – Mercury.

This fact was discovered by N. A. Morozov. When he was verifying Brugsch's identifications, he noticed the fact that the inscription in question might just as easily refer to Venus as to Mercury, since the latter is an inside planet, just like the former, which means that the distance between them and the Sun is smaller than that between the Sun and the Earth. There are two such planets – namely, Venus and Mercury. Their "inside disposition" (as related to the telluric orbit) results in limited visibility of these planets from the Earth – one only sees them in the morning or in the evening, when the Sun isn't too far away from the line of the horizon. Mercury is closer to the Sun than Venus, and so the name "god of the morning" fits it even better. Furthermore, the Egyptologists are well aware of the fact that the name "morning star" could refer to both Venus and Mercury in the Egyptian inscriptions ([1009:1], page 117). However, there are other planetary symbols for Venus in the Dendera Zodiacs, and they fit the planet a great deal better. We are referring to the abovementioned pair of wayfaring women carrying rods from the Round Zodiac and the girl with the rod accompanied by a male figure with a leonine head that we see in the Long Zodiac ([544], Volume 6, pages 652 and 659). See also figs. 15.41 and 15.42.

Let us point out that the true figure of Venus as seen in the Long Zodiac is so close to Mercury (mistaken

Fig. 15.41. The Round Zodiac of Dendera (DR). N. A. Morozov's correction of Brugsch's error in the identification of Venus. Brugsch had suggested that Venus should be identified as the two-faced male figure (highlighted by dots). Morozov subsequently demonstrated the figure in question to be Mercury, since the two women with rods (also highlighted by dots) are much more likely to represent Venus. Based on the drawn copy of the Round Zodiac from [1062], page 71.

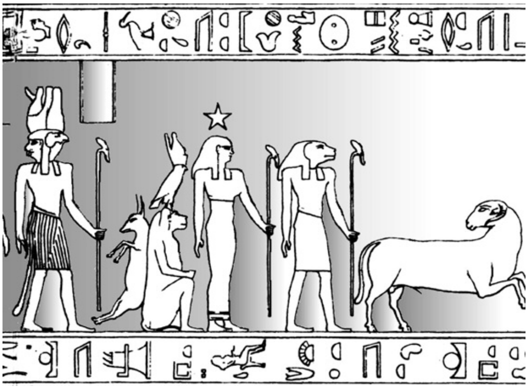


Fig. 15.42. Long Zodiac of Dendera (DL). N. A. Morozov's correction of Brugsch's error in the identification of Venus. Brugsch had suggested that Venus should be identified as the two-faced male figure (on the left of the picture). Morozov demonstrated it to be Mercury, since Venus is represented by the young woman with a rod preceded by an auxiliary male figure (Morozov was using a bad copy and presumed the other figure to be female as well). Morozov is perfectly correct, since Venus would always be drawn as a woman, or a woman accompanied by a man (the way we see it in the present drawing), but never a single male figure. Based on the "Napoleonic" copy of the Long Zodiac ([1100], A. Vol. IV, Pl. 20).

for Venus by Brugsch) that the hieroglyphic inscription that he had discovered could indeed refer to Venus, just as he had thought, qv in fig. 15.42. In other words, it is possible that Brugsch's interpretation of the inscription was correct, unlike his presumption that the inscription in question really referred to the neighbouring figure of Mercury. At any rate, Brugsch's mistake with Venus became perfectly obvious after Morozov's research, and the constant recurrence of this mistake in the works of the Egyptologists is odd at the very least, if not to say suspicious.

Morozov himself wrote the following in this respect: "we see a wayfarer wearing the headdress of a head priest in Aries; he bears a rod, which is a mark of a planet. The head with two faces, one of them human and the other aquiline, could be identified as Mercury who keeps popping up from both sides of the Sun; however, Brugsch says we have an inscription that says "Pnouter-Ti" here – "god (or goddess) of the morning", identifying the figure as Venus because of this. However, one could doubt his guess. We see the drawing that stands for the dusk and the dawn as two little beasts with their backs grown together to the right of this figure. Above them we see two young women bearing rods, one of them has a human face and the other – a canine one; this must be the double drawing of Venus as the morning and the evening star" ([544], Volume 6, page 653; see also fig. 15.42).

Morozov's text contains a minor error here – we see just one young woman bearing a rod in the Long Zodiac and not two. The second figure with the rod and a "canine snout" is in fact male, qv in figs. 15.42 and 15.39 (DL). However, in general, Morozov points out Venus in the Long Zodiac perfectly correctly. It looks like a young woman with a rod accompanied by a male figure (which Morozov mistook for the other young woman – see fig. 15.39 (DL). For the most part, the female planetary figure of Venus is accompanied by yet another planetary figure, which might either be male or female. However, we shall see that "male" planets were never drawn by Egyptians as surrounded by female planetary figures – and, in particular, Venus was never drawn as a lone male figure anywhere either in Egyptian astronomical symbolism – or European, for that matter; Venus is always a female character in astronomical symbolism as well as mythology ([532], page 121). Drawing Venus as a female is a rule of old astronomy rigorously followed in the Egyptian zodiacal tradition.

On the other hand, the two-faced male figure is an ideal symbol for Mercury. Bear in mind that Mercury (or Hermes in Greek mythology) is a male character ([532], page 361). As for the double face – from the astronomical point of view, it is most likely to stand for an inside planet that one sees in the morning and in the evening. Such planets cannot be observed in between since the rays of the Sun render them invisible. They used to be considered "double" planets in ancient astronomy, since it was presumed that the morning and evening manifestations of these planets were different celestial bodies ([544], Volume 6, page 697). It was only later that the astronomers managed to get an understanding of the matter at hand. The Egyptian zodiacs already reflect the astronomically correct understanding of the nature of such planets, which serves as indirect proof of the relatively late origins of the Egyptian zodiacs. However, the remnants of the old concept of the inner planets being the morning star and the evening star are still present in the Egyptian

symbolism, reflected in the two faces of Mercury and the double drawings of Venus. Thus, Venus is drawn as two planetary figures at once in the zodiacs of Dendera and Esna (see fig. 15.39).

Thus, the astronomical ambiguity of Venus as an inside planet was reflected in the Egyptian zodiacs in the fact that it would be represented by a pair of planetary figures – two women or a man and a woman.

One wonders how the Egyptologists explain the presence of a certain female planetary figure amidst the constellations, at a considerable distance from Mercury that they already identified as Venus? They are left with no opportunity of identifying it. Indeed, the real figure of Venus is obviously a problem – the learned scholars have no idea as to what to do with it. The in-depth study of the Round Zodiac carried out by Sylvia Cauville, a contemporary French Egyptologist ([1062]) remains perfectly silent on the subject of the two female planetary figures that represent Venus, qv in fig. 15.39 (DR) – as if said figures didn't exist. Nevertheless, we see attempts of astronomical explanation made for every other figure that we find in the vicinity of the constellation belt in the Round Zodiac in [1062]. Leaving the question of their validity aside, we feel obliged to mention the fact that the stubborn reticence of the Egyptologists in re the true figure of Venus from the Round Zodiac indicates the fact that the Egyptologists are apparently aware of Brugsch's opinion that Venus is represented by the two-faced male figure in the Egyptian zodiacs. It becomes unclear what exactly might preclude them from correcting Brugsch's error. Could it be that it's considered *mauvais ton* for an Egyptologist to mention the errors made by the eminent specialists? In that case it is most likely that the Egyptologists simply aren't interested in the correct astronomical datings of the Egyptian zodiacs for they have been aware of the fact that such datings will blatantly contradict the chronology of Egypt that they adhere to ever since the publication of N. A. Morozov's works.

By the way, despite referring to the reproduction of Mercury from the Round Zodiac published in [1062] as to Venus, Sylvia Cauville nevertheless translates the hieroglyphic inscription over the head of Mercury as "le dieu du matin", or "the god of the morning", the word for "god" being explicitly male in gender, which once again emphasizes the male sex of the figure in question – obvious even without commentary, qv in fig. 15.45 (DR) below, for instance. Let us point out that Egyptian hieroglyphs have special indicators of the female gender ([370], page 19) that aren't present in this inscription, which utilises the male gender, as it is obvious from Cauville's translation.

It has to be said that in certain cases Egyptologists do identify Venus and Mercury in the zodiacs correctly, the female planetary figure as Venus and the two-faced male one as Mercury. However, this only appears to apply to the Egyptian zodiacs which weren't studied by such classics of Egyptology as H. Brugsch. Thus, their interpretation does not present the risk of contradicting the opinion of an eminent figure of authority. For example, the modern specialists in the astronomical texts of the "ancient" Egypt, the well-known Egyptologists O. Neugebauer, R. Parker and D. Pingree provide an interpretation of the planetary symbols from the zodiac P2 from the inner chamber of the tomb of Petosiris in [1291], the work that we already discussed above. Planets are drawn as busts in this zodiac, two of which are female (see fig. 15.43). One of them is marked by a crescent and can thus be unambiguously identified as the Moon, qv in fig. 15.43. The other female bust must therefore represent Venus, whereas the two-faced male bust is Mercury. After all, if we are to go by Brugsch's idea that the two-faced male figure on the zodiacs of Dendera identifies as Venus, the two-faced bearded bust from Zodiac P2 should symbolise Venus with one of its faces. However, we find this to be impossible here, qv in fig. 15.43. Otherwise one would have to ascribe the bearded face to Venus, as well as identifying the "vacant" female bust with some purely "male" planet. Let us also point out that there are none of the auxiliary symbols in the zodiac P2 that one finds in the Zodiacs of Dendera, for instance. The quantity of busts corresponds to the number of planets precisely, and the issue of identifying Venus and Mercury is solved unambiguously. Therefore, Brugsch's error is perfectly obvious here.

Let us return to fig. 15.39. In the "Coloured Theban" zodiac OU we have a single candidate that can be identified as Venus, namely, the female figure over the constellation of Leo, qv in fig. 15.39 (OU). Planetary figures have no rods in this zodiac. See more on the "Coloured Theban" zodiac below, in the section related to the dating thereof.

Fig. 15.43. Planets in the P2 zodiac look like busts whose number corresponds to that of the planets perfectly. The symbols of Venus and Mercury can be identified instantly and reliably. One of the two female busts is accompanied by a rather explicit crescent, and can therefore be identified as the Moon, which makes the remaining female bust stand for Venus, and the two-faced male bust as Mercury. This is how Neugebauer, Parker and Pingry interpret these drawings, see [1291], page 98. The error of Brugsch, who had misidentified the two-faced male figure as Venus, becomes quite obvious from this zodiac. Based on the drawn copy from [1291], Tafel 41.

In the Athribis zodiacs of Flinders Petrie the bird figure representing Venus was identified as a result of computer calculations accounting for all the options. Therefore, the circles representing the zodiacs AV and AN in fig. 15.39 are shaded grey.

We already discussed the name of Venus in the demotic horoscope from the zodiac of Brugsch. Here we wholly rely on the translation of the demotic inscriptions made by Brugsch.

In another horoscope from the same zodiac (the "horoscope with boats") we can identify Venus instantly – it is the only female planetary figure that we see here (gig. 15.39 (BR)).

The drawing of Venus from the third and final horoscope that we find in Brugsch's zodiac (the "horoscope without rods") is very odd indeed, qv in fig. 13.17 above. We only managed to identify Venus after having excluded all other planets. The only vacant symbol that we ended up with is the lioness with the tail of a crocodile, with a crocodile underneath, qv in fig. 15.39 (BR). However, the Crocodile might pertain to the symbolism of the Leo constellation, where we find Venus in this case. In the OU zodiac, where Venus is also in Leo, we see a very similar crocodile under the constellation figure, qv in fig. 15.39 (OU).

Let us also point out that the sign of the lioness (usually as a leonine head) often accompanies Venus in the Egyptian zodiacs. We shall witness this on nu-

merous occasions in our study of the secondary horoscope. However, this attribute is also frequently encountered in primary horoscopes. For instance, one of the two figures that represent Venus in the primary horoscopes on the zodiacs of Esna and Dendera has the head of a lioness, qv in fig. 15.39. The fact that the head in question is leonine and not canine, as N. A. Morozov had thought (apparently, due to the poor quality of the illustrations that he was using) is illustrated by fig. 14.7 above, for instance, where we see a multitude of Egyptian planetary symbols. Only one figure of those is a woman with a leonine head, the so-called "goddess Sekhmet", qv in fig. 14.7. Effigies of this "goddess" were often found in the "ancient" Egypt. One of such effigies is exhibited in the Hermitage (St. Petersburg) – a sitting granite humans-sized statue of Sekhmet. A photograph of this statue can be seen in fig. 15.44. One plainly sees that Venus (or Sekhmet) has the head of a lioness.

Another attribute of Venus, which it has "in common" with Mercury is a vertical serpent. We shall discuss this symbol in detail below, once we reach the section on the respective characteristics of Mercury, qv in CHRON3, Chapter 15:4.10.

Fig. 15.44. Ancient Egyptian statue of Venus as "the goddess Sekhmet" from the State Hermitage in St. Petersburg, Russia. The view of the entire statue is on the left, and its head is on the right. One can plainly see this to be a leonine head. The museum plaque bears the following legend: "Statue of the goddess Mut (Sokhmet). Egypt. Thebes". Photograph taken in 2000.

Let us conclude with the observation that Venus was also known under the names of Aphrodite, Isis and Astarthe ([532], page 121). In the Scandinavian mythology Venus corresponds to the goddess Freia ([393], page 42).

The weekday dedicated to Venus is Friday. The English name stems from "Freia's day", whereas the Latin *Dies Veneris* stands for "The Day of Venus" ([393], page 41).

4.9. Mercury in the primary horoscope

Drawings of Mercury from the primary horoscopes of different zodiacs can be seen in fig. 15.45. Each of the drawing's cells corresponds to a single zodiac, whose indication is given in the circle inside the cell. The circles of the zodiacs marked EM, EB and OU in fig. 15.45 are shaded grey, which means that Mercury was found as a result of computer calculations with all possible options sorted through. In all the other zodiacs we managed to identify Mercury instantly, before performing any astronomical calculations.

We do not cite the drawings of Mercury from the zodiacs of Petosiris in fig. 15.39. See the section concerned with the dating of these zodiacs below, as well as fig. 15.43.

Three various drawings of Mercury are given for Brugsch's zodiac in fig. 15.45 (BR) – one for each of the primary horoscopes contained in this zodiac – the "demotic" horoscope, the "horoscope without rods" and the "horoscope with boats". In the first one, the name of Mercury is written in demotic script between Scorpio and Libra. It was interpreted as "*Sebek*" by Brugsch, which stands for Mercury ([544], Volume 6, page 697).

In the two other horoscopes of Brugsch Mercury is drawn as human figures, qv in fig. 15.39 (BR).

As we have already mentioned above in re the error of H. Brugsch who confused Venus with Mercury in the zodiacs of Dendera, Mercury was often drawn as a two-faced male figure in the Egyptian zodiacs. This two-faced representation corresponds well to the astronomical nature of Mercury. In his analysis of the planets in the Round Zodiac of Dendera, qv in fig. 15.45 (DR), N. A. Morozov writes the following:

"In between the constellations of Pisces and Aquar-

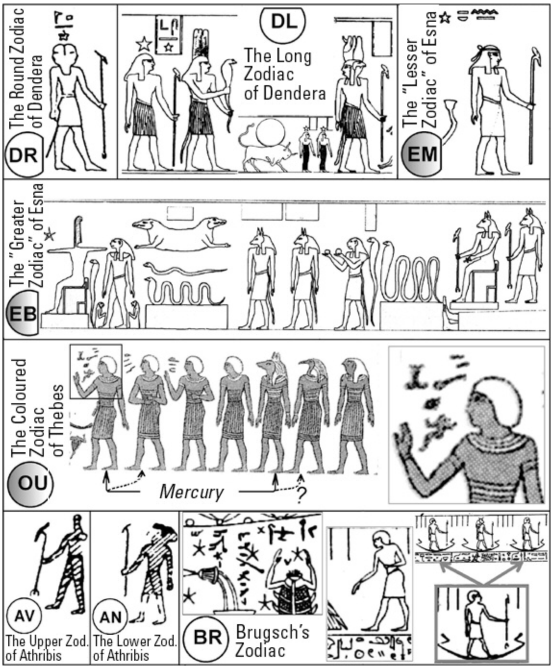


Fig. 15.45. Mercury in the primary horoscope of various Egyptian zodiacs. Cells with grey circles (EM, EB and OU) refer to calculated identifications of the planet with all possible versions of identifying birds as planets taken into account. The zodiacs of Petosiris are not represented. In the DL zodiac we see two representations of Mercury in the primary horoscope at once, since it is a fast moving planet – one stands for the visible position of the planet, and the other – for the invisible. All the figures we see in the DL cell between the two symbols of Mercury were reduced in size for better representation. Fragments taken from [1100], [1062] and [544], Volume 6.

ius we see a wayfarer carrying a rod who looks like the two-faced god Janus with a star over his head. It is the planet Mercury that never leaves the solar vicinity and can only be observed for a few days, showing each of his two faces – the first in the West at dust and the second in the east at Dawn. Astronomical symbolism of the antiquity doesn't permit two interpretations ([544], Volume 6, page 659).

These words of N. A. Morozov are most demonstrably confirmed by the symbolism of zodiac P2 from the inner chamber of the tomb of Petosiris, whose drawn copy we already cited in fig. 15.43 above. In this Egyptian zodiac Mercury is drawn as a man with two faces, one of which is turned towards the Sun and left unshaded, whereas the second is turned away from the sun and shaded black. The astronomical meaning of these symbols is obvious. The face turned towards the Sun is illuminated by the solar rays, whereas the one that faces the other direction remains beyond their reach. Thus, one can say that Mercury shows us the two faces that it has as it can be observed from both sides of the sun, which corresponds with the above quotation from Morozov perfectly.

As for Morozov's guess concerning the fact that the Egyptian Mercury corresponded to the two-faced Roman god Janus (the "two-faced Ivan"), we already mentioned it as we analysed the Saturnine symbolism. We deem Morozov to be perfectly right here. Additional considerations that we have in this respect will be cited at the end of the present section.

Thus, we shall be adhering to the following rule in the course of our research.

If we see a two-faced male planetary figure in an Egyptian zodiac, we presume it to stand for Mercury.

One has to note that this rule isn't always of use. In some of the Egyptian zodiacs there are no two-faced planetary figures. In such cases Mercury could be drawn with a single face – usually human, but occasionally also a jackal's head. We already mentioned the fact that the Egyptian "god Anubis" with the head of a jackal can be identified as Mercury (or Hermes). See more on the similarity between the images of Mercury and Saturn in the ancient astral symbolism above.

Wednesday was the week day consecrated to Mercury ([155], page 66; see also [393], page 44).

4.10. The attributes of Mercury in the Egyptian zodiacs

In the course of our research we have discovered that Mercury often possesses the same attributes in different Egyptian zodiacs. They are useful for estimating Mercury's position in a zodiac in complex and ambiguous cases. Among such symbolic attributes we find the following:

1) Bicephalous or two-faced creatures facing opposite directions. Sometimes their bicephalous nature is replaced by a pair of arms spread wide. These symbols are manifest the most in the "Greater Zodiac" of Esna (EB). We see both a two-faced animal and a

human figure with arms stretched sideways, with two identical little animals below drawn as facing each other, qv in fig. 15.45 (EB). Mercury itself is drawn here as two jackal-headed figures – one sitting and the other standing, qv in fig. 15.45 (EB). The sitting figure with the spread arms can be seen next to Mercury in the "coloured Theban zodiac" (OU). It is part of the hieroglyphic inscription near Mercury's head, qv in fig. 15.45 (EB).

2) A serpent-shaped rod in the hands of Mercury, or simply a vertical drawing of a snake nearby. May also serve as an attribute of Venus – on the zodiacs of Esna, for instance. Such snakes accompany Mercury the most often in secondary horoscopes of the Egyptian zodiacs, but we also occasionally encounter them in the primary horoscopes. For instance, next to the abovementioned sitting figure with arms stretched to the side in fig. 15.45 (EB) we see a vertically-aligned drawing of a snake. This snake may also be bicephalous, qv in the secondary summer solstice horoscope from the "Greater Zodiac" of Esna (EB), qv below. Let us point out that *horizontal* drawings of snakes, bicephalous ones included, turn up in everywhere in the Egyptian zodiacs and don't serve as symbols of Mercury. Some of them indicate equinox points, as we shall see below.

Also, even vertical drawings of snakes don't necessarily have to stand for Mercury in the Egyptian drawings. For instance, a cobra on a pedestal with a raised head might stand for an equinox point, qv below. In some cases vertically-aligned snakes are seen in the vicinity of other planetary symbols – Venus, for instance; see also our discussion of secondary horoscopes in the EM zodiac below. However, such cases are rather rare; on the contrary, we see such snakes near Mercury very often. Sometimes they can be used to identify the position of Mercury in an Egyptian zodiac. Whether or not this theory is veracious can be estimated from calculations.

3) The feather on the head of a figure can often serve as an attribute of Mercury (however, this doesn't necessarily have to be the case). It can stand for Mercury in secondary horoscopes – the summer solstice horoscope in Gemini, for example, as we shall see below. The abovementioned sitting figure with stretched arms that we see in Mercury's entourage has got a feather instead of a head, qv in fig. 15.45 (EB).

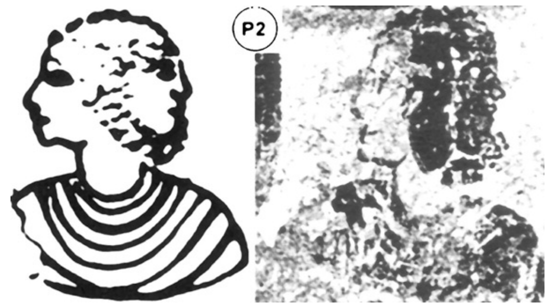


Fig. 15.46. Planetary figure of Mercury in the P2 zodiac from the inner chamber of the Egyptian tomb of Petosiris. The drawn copy is on the left, and the photograph is on the right. Mercury looks like a two-faced man. One of his faces is turned towards the sun and therefore drawn white, whereas the other is facing the opposite direction and drawn darkened, or shadowed. Taken from [1291], Tafel 40 & 41.

4.11. Mercury drawn in two positions simultaneously

One of Mercury's primary characteristics is its rapid movement across the celestial sphere. Mercury moves faster than any other planet except for the Moon. Therefore, Mercury's position could vary to a great extent within the confines of the primary horoscope's date. This would lead to Mercury becoming indicated twice on certain Egyptian zodiacs. We see this to be the case in the Long Zodiac of Dendera, for instance, for which we saw Mercury in both positions – visible as well as invisible.

One has to say that the date of an Egyptian zodiac as transcribed in a primary horoscope could be stretched into a sequence of several days, owing to the fact that the "ancient" Egyptian creators of one zodiac or another may have had objectives other than indicating the hour or even the day of the event that the zodiac in question commemorates with exactitude. It is possible that they only knew the week where the event that they're interested in had happened. One still finds traces of the ancient timekeeping method that was based upon weeks counted from Easter in the Orthodox ecclesiastical calendar.

The fact that Mercury is drawn twice in the Long Zodiac of Dendera (once in its visible position, and once invisible, "hiding" behind the Sun) was pointed out by N. A. Morozov, who wrote that "the only fig-

ure left here [in the Round Zodiac – Auth.] for Mercury is the two-faced Janus between Pisces and Aquarius, which is why I believe this figure on the rectangular zodiac [the Long Zodiac – Auth.] to be a second representation of his, one that hides behind the Sun" ([544], Volume 6, page 654). N. A. Morozov is perfectly correct to point out the second representation of Mercury in the Long Zodiac. Unfortunately, he failed to recognize its first representation in the zodiac, having mistaken it for "a comet in the evening sky" ([544], Volume 6, page 677). As we already pointed out above, Morozov would mention comets every time he failed to identify a planetary figure. We haven't found a single comet in any Egyptian zodiac; even if they were drawn , it must have been on very rare occurrences.

In fig. 15.45 (DL) we cite a fragment of the Long Zodiac of Dendera where one sees two drawings of Mercury. One of them looks like two men, one following another. The one on the left is holding a planetary rod in his hand. Another is holding a snake, and there are two feathers on his head. The visibility of Mercury is symbolised by the star over the head of the man with the rod. Another representation of Mercury can be found on the other side of the figure of Taurus with the Sun over its back (this figure is somewhat smaller in fig. 15.45 (DL)). There is no star over the head of Mercury here, since the planet was invisible in this position, obscured by the Sun. As we shall see below, the entire picture of Mercury passing by the Sun corresponds ideally to the real situation as observed on the celestial sphere. In general, the visibility of planets would be reflected in the Egyptian zodiacs in the most meticulous manner possible. This must be the reason why Mercury, whose position for the zodiacal date changed from visible to invisible, was drawn in the Long Zodiac twice. See the section on the dating of the Long Zodiac of Dendera below.

Mercury is also drawn twice in the "horoscope with boats" from Brugsch's zodiac, where it is represented by two similar male planetary figures in boats that we see on either side of Saturn's figure, qv in fig. 15.45 (BR). Apparently, the underlying concept implied the demonstration of Mercury's visible position as well as the invisible. This happened when a fast Mercury turned up on the other side of the slowly-moving Saturn, which is what the second figure of Mercury on the zodiac must stand for.

4.12 Mercury as the symbol of the "two-faced god" Janus (Ivan)

Let us voice some of our considerations in re Morozov's suggestion that Mercury corresponded to the two-faced god Janus in Roman mythology, or "Ivan the god", since the name Janus (or Ian/Jan) is the same as Ivan, serving the western Slavs as the indication of the latter, for instance.

We have already pointed out Hermes being the Greek name of Mercury ([532], page 151). According to linguists, it stems from the Greek word *Herma* which translates as "a pile of rocks" or "a menhir" ([532], page 151). It is also presumed that "the hermae were roadmarks … guardians of roads, borders and gates (hence the "private, hidden" connotation of Hermetic – Propylaea etc), qv in [532], page 151. Thus, the Greek name of Mercury (Hermes) could be interpreted along the lines of "Guardian of the gates". On the other hand, the Roman Janus is presumed to be the "god of gates" – specialists even claim his name to originate from the word "gate". Thus, the "Mythological dictionary" tells us the following about Janus:

"Janus (derived from *ianua*, "door" or "gate") – the god of doors, exits and entrances in Roman mythology (his epithets are "the opener" and "the closer") …" ([532], page 679).

We thus see that the Hermes and Janus as Mercury's names all referred to the same entity; the cults of both "ancient deities" were rather close, and could have merged and transformed into one another.

Janus is known to have been drawn with two faces: "Janus was drawn with keys, 365 fingers to correspond to the number of days in the year that he opened, and with two faces looking in opposite direction (hence his name "double", or *Geminus*" ([532], page 679). Ancient mythology doesn't make it quite clear just why he would have two faces. "His two-faced nature was explained by the fact that doors lead into a house as well as out … as well as the fact that he possesses the knowledge of the past and the future" ([532], page 679). The explanation might seem somewhat far-fetched; however, Mercury (or Hermes) had even more reasons to be represented as a two-faced deity, since he presumably "had equal access to both worlds, the world of the living and the world of the dead; he served as an intermediate between the two,

also serving the gods and the people in this capacity ([532], page 151). Quite obviously, from the symbolical point of view, the two-faced nature of Mercury (or Hermes) will correspond perfectly to his nature of an intermediate. This makes us all the more certain that the Roman Janus is the same entity as Hermes or Mercury.

As we already pointed out, according to our reconstruction, the myths of the "ancient Roman god" Janus (Ivan) are most likely to be an allegorical rendition of the biography of Ivan Danilovich Kalita (Kaliph), the Great Empire's founder who had lived in the XIV century A.D. Bear in mind that Janus (Ivan Kalita) was considered the first and the main deity as well as the "arranger of global order". The ***Dictionary of Mythology*** tells us that "Janus was summoned first whenever the gods were called upon. He was considered the first king of Latius (Latius/Ratius/Ras/Russia – Auth.) … He received Saturn and shared power with him … his priest was the "priest of holy ceremonies", or *rex sacrorum,* who could act as a substitute of the king and stood at the very top of the Roman ecclesial hierarchy … In a song of the Salians Janus was called "lord of the lords" and "the good creator" … his symbolism would later become interpreted as that of the … primordial chaos which gave birth to the ordered Cosmos (or the Great Empire with its clockwork machinery of state that spanned vast territories, bringing an end to the chaos of disjointed states, which had existed previously – Auth.), having thus … transformed into a deity and become a god as well as the sentinel of peace and order" ([532], page 649).

The two-faced or double nature of Janus (Hermes) could, in particular, symbolize the fact that the Great Empire was founded by two brothers – George of Moscow, or Genghis-Khan, and Ivan Kalita, or Batu-Khan, qv in CHRON4. Let us also point out the apparent similarity between Her-Mes and George of Moscow (*Georgiy Moskovskiy*) that complements the identical nature of the names Janus and Ivan. The similarity is in good correspondence with our hypothesis, although obviously cannot serve as any proof of anything at all per se.

Mercury was once considered "the most important deity" in the British Isles. This is what the ***History of the Brits*** by Galfridus Monmutensis is telling us (a source dated to the XII century A.D. by modern historians, qv in [393], page 44; however, the rectified chronology claims it most likely to have been written in the epoch of the XV-XVII century. After that it had gone through the hands of the Scaligerite editors of the XVII-XVIII century, likewise all the other old texts. This is what we read in the chronicle of Galfridus:

"We revere the gods of our fathers – Saturn, Jupiter and other rulers of the world, but especially Mercury whom we call Woden in our language. Our predecessors have consecrated the fourth day of the week to him [Wednesday, since the first day of the week was Sunday – Auth.], which we still call Wednesday, or Woden's Day" ([155], page 66; see also [393], page 44).

Thus, it turns out that Mercury stands for Woden (Wotan), the primary deity of the ancient Germans, and therefore also Odin, his Scandinavian equivalent:

"Odin is the main deity in Scandinavian mythology that corresponds to Woden (Wotan) of the Continental Germans … Woden is parallel to the Roman Mercury and shares the day of the week with him (Wednesday) … in Scandinavian mythology Odin heads the pantheon, the first and main Ace … he lives in Asgard [As-Gard, or the Horde of the Aces – Auth.] – a celestial dwelling with silver-plated domes [the palaces of the Czars, or Khans, were really plated with gold, but Scandinavian bards were apparently unable to conceive of it – Auth.] … In the ***Deeds of the Danish*** by Grammaticus the Saxon … Odin and the other gods are *depicted as ancient kings* [which is correct – Auth.] … The Anglo-Saxon kings trace their ancestral lineage to Woden. The Danish royal court (according to Beowulf, the Anglo-Saxon epos) is descended from Skjald, the son of Odin. According to the Walsung Saga, Odin is the first patriarch of the legendary royal family of the Walsungs, which Sigurd, or Siegfried, the famous hero of the German epos, also belongs to" ([532], page 410-411).

According to our reconstruction, the person in question is most likely to be the Great Prince Georgiy Danilovich of Moscow, the founder of the Great = "Mongolian" Empire, likewise his brother Ivan Kalita. The Great Prince George appears in history and ancient myths alike under many different names such as:

Genghis-Khan, or, possibly, the "Khan of the Seas", since *denghiz* is the Turkish word for "sea",

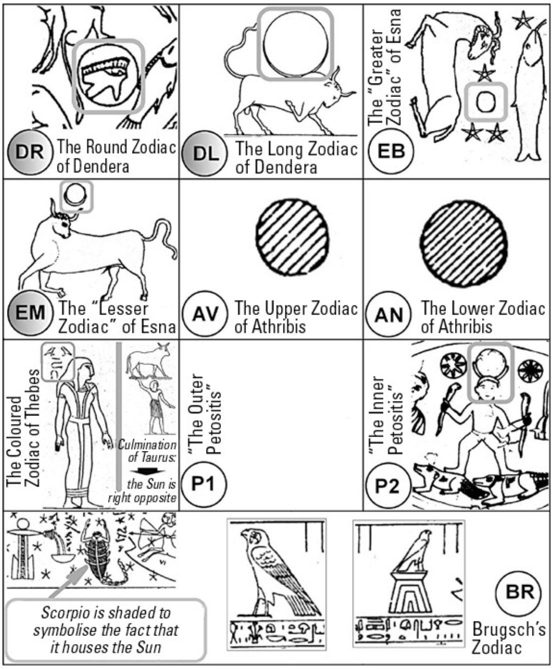


Fig. 15.47. The Sun in the primary horoscope of various Egyptian zodiacs. Cells with grey circles refer to calculated identifications of the Sun with all possible versions of identification taken into account. Fragments taken from [1100], [1291] and [1062].

Hermes, or, possibly, George of Moscow,

Odin, which translates as "the single" (*odin* stands for "one" or "only" in Russian) – which must have merely been a reference to his functioning as an autocrat,

Woden (possibly, *wodniy* – "aquatic", or "related to water").

Over the course of time, the mythologized image of George the Muscovite became twined with that of his brother Ivan Kalita who had brought the endeavour initiated by the former to completion and created the Great Empire, qv in CHRON5. Their double image must have laid the foundations for the cult of Janus (Mercury/Hermes), the "two-faced god".

There is a curious detail that we would like to conclude with. Ivan Kalita's nickname (that stands in lieu of a surname here) is the word used for a burse, or a wallet. It is presumed that this name comes from the size of his wealth ([85], Volume 19, page 437). However, this is in ideal correspondence with how the "ancient" Romans usually portrayed Mercury: "As the god of wealth and income, Mercury would usually be drawn with a bourse" ([532], page 361).

4.13. The Sun in the primary horoscope

In fig. 15.47 one sees how the Sun is depicted in the primary horoscope in various Egyptian zodiacs. The grey circles, as above, indicate the zodiacs for which we'd had several identification options for the Sun in the primary horoscope. In these cases, the finite version as seen in fig. 15.47 was arrived at as a result of astronomical calculations and tests of their compliance with the secondary horoscopes. We shall be telling more about this in the sections related to the dating of the individual horoscopes.

As one can see from fig. 15.47, the Sun would most often be drawn as a circle in the Egyptian zodiacs. Sometimes one could see a narrow line of a crescent near one of its edges, which must stand for the new moon that is usually observed near the Sun. Indeed, the size of the lunar crescent is defined by the visible part of the lunar half illuminated by the Sun as observed from the Earth. For instance, when the distance between the Sun and the Moon on the celestial sphere is the greatest – that is, when the Earth is in the middle of that distance, these celestial bodies would oppose each other as seen by a telluric observer, with the entire illuminated lunar half visible. This is when full moons occur. On the contrary, when the Sun and the Moon get close to each other on the celestial sphere and the Moon gets in between the Sun and Earth, its illuminated half that always faces the Sun cannot be seen from the Earth. This is when the lunar crescent "fades away" and the night becomes moonless. The next day one sees a narrow crescent of the new moon. Since the Moon doesn't get too far away from the Sun over a single day, this crescent is always near the sun. Therefore, drawing a narrow crescent near the edge of the Sun makes sense from the astronomical point of view.

The narrow crescent is added to the Solar circle in the zodiacs DL (the Long Zodiac of Dendera), EM (The Lesser Zodiac of Esna), and P2 (the inner chamber of Petosiris), qv in fig. 15.47.

In some of the Egyptian zodiacs the Sun is repre-

sented in a rather implicit manner. In the demotic subscript horoscope from Brugsch's zodiac (BR), the Sun isn't drawn, nor is its name written anywhere, qv in figs. 12.17 and 13.14 above. Nevertheless, its position in Scorpio is indicated quite unmistakably – the symbol of Scorpio is shaded as a sign of it containing the Sun. This was noticed by N. A. Morozov, who had studied the demotic subscript horoscope in the BR zodiac meticulously. According to what he writes in [544], Volume 6, page 696, "the figure of Scorpio is the only one of the 12 zodiacal figures to be shaded, which symbolizes its disappearance from sight due to sunshine; this takes place in November, whereas the figure of Taurus that opposes it is shaded black to symbolize the fact that it reigns all night long, or culminates at midnight". See also fig. 15.47 (BR).

Let us explain that under the culmination of a constellation we understand its maximal elevation over the horizon as observed on the celestial sphere. Obviously, the constellation that culminates at midnight is the one that's located on the opposite of the Sun on the ecliptic, qv in fig. 15.48. Furthermore, being located on the opposite of the Sun on the ecliptic at dusk, this constellation begins to rise right across the sky in the east. When the night ends and the Sun rises in the east, this constellation disappears under the horizon in the west. Thus, the constellation in question rises in the evening and sets in the morning, and can be observed in the sky all night long. All the other zodiacal constellations can only be seen during a part of the night; they either rise after sunset, or set before sunrise. Thus, the constellation that culminates at midnight really "reigns" all night long. There is an indication of this in Brugsch's zodiac, as Morozov duly points out, namely, the fact that the constellation of Taurus is shaded black.

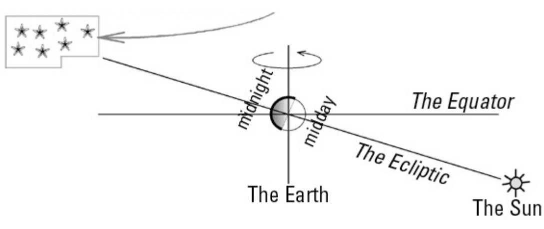


Fig. 15.48. The constellation that rises the highest above the horizon at midnight is the one that is located on the opposite side of the ecliptic from the Sun. In other words, the constellation that opposes the Sun culminates at midnight. Therefore, the solar position for a given day can be indicated in the zodiac without the use of the actual solar figure – simply by highlighting the culminating constellation. This method was used in some Egyptian zodiacs, namely, zodiacs OU and BR.

Fig. 15.49. The "Coloured Theban Zodiac" OU. A hieroglyphic inscription next to the head of Virgo. Birds in the upper part of the inscription are most likely a reference to the Sun, which had been in Virgo on the day of the horoscope, according to calculations (see the section on the dating of the OU zodiac). Illustration fragment from [1100], Plate 82.

In the two other horoscopes from Brugsch's zodiac (let us remind the reader that there are three primary horoscopes in this zodiac, qv above) the Sun is drawn as a bird, qv in fig. 15.47 (BR). Below, in our analysis of secondary horoscopes, we shall see that the Sun would indeed often be depicted as a bird in those. In the summer solstice horoscope that we already mentioned above, for instance, the Sun would often be drawn as a bird sitting on a pole, qv in fig. 14.6 above.

In the Long Zodiac of Dendera the sun in the secondary horoscopes is drawn as a bird several time. The bird that symbolises the Sun "flies" from one constellation to another.

The representation of the Sun in the "coloured Theban" zodiac OU is of the utmost interest indeed. There is no symbol of the Sun here, and so we have to find it using indirect indications – this is an easy enough task. Note that the constellation of Taurus is explicitly marked as culminating – the symbol stands on a dais of sorts, which is raised high in the air by a human figure, qv in fig. 15.47 (OU). This means that the Sun was located in the part of the ecliptic that opposes Taurus. These constellations are Scorpio and Libra, and also possibly the adjacent parts of the neighbouring constellations, Sagittarius and Virgo. Calculations demonstrate that the Sun that day was in Virgo, near the cusp with Libra, qv below, in the section on the dating of the OU zodiac. We should note that it was near the figure of Virgo that we see a hieroglyphic inscription that looks like two birds facing each other with three hieroglyphs below, qv in fig. 15.49. It is possible that the inscription refers to the

position of the Sun in this constellation, since the Sun could be drawn as a bird by the Egyptian artists.

In general, locating the Sun and the Moon in the Egyptian zodiacs isn't a complex task. However, due to the fact that the symbols used therein for both are very similar to each other, one would often have to consider several options of identifying the Moon and the Sun. Sometimes the number of options would grow due to the fact that the Sun in the secondary spring equinox horoscope would be indicated by the same symbols as the ones found in the primary horoscope. In these cases, we are incapable of singling out the solar symbol pertinent to the primary horoscope, and we have to consider all the other options. This is the case with both zodiacs of Dendera, for instance, qv below.

The day consecrated to the Sun is Sunday. This used to be the first day in a week in the old astronomical count. The Latin name of Sunday (*Dies Solis*) stands for "Day of the Sun" ([393], page 41).

4.14. The astronomical symbolism of the Egyptian "eye" symbol

In the Round Zodiac of Dendera we see the Egyptian "eye" symbol in the solar circle between Pisces and Aries. It looks like a gallinaceous eye, but might mean something different since we haven't found a single drawing of a cock that we could identify as such without ambiguity. The fact that the abovementioned circle from the Round Zodiac is solar and not lunar was discovered as a result of astronomical calculations. In particular, we have considered the versions that suggest its lunar nature. None of them withheld the test for compliance with either planetary visibility attributes or secondary horoscopes, and were therefore rejected.

One of the reasons why the circle with an eye from the Round Zodiac cannot be identified as the Moon is as follows. Let us consider the fragment of the Round Zodiac that we see in fig. 15.50. Both of the planets that one finds near the sun, Venus and Mercury, are all in Aries, Pisces or Aquarius in the Round Zodiac. Venus is represented by the two female wayfaring figures between Pisces and Aries, whereas Mercury is a two-faced male figure with a rod between Pisces and Aquarius, which implies that the Sun should be nearby, since neither of these two planets ever travels too far away from the Sun.

Moreover, there are only two circles nearby that can stand for either the Sun or the Moon, both of them near the symbol of Pisces. One of them (a circle with an eye) is located between Pisces and Aries, near Venus. The other one, with the figure of a young woman inside, is in Pisces (the side of Aquarius, near Mercury, qv in fig. 15.50).

Therefore, since the Sun should be somewhere in this vicinity, it means that if the circle with the eye stood for the Moon, the other circle (with the young woman) should invariably represent the Sun in the primary horoscope, which would otherwise be left with no valid symbols for it. However, this fails to concur with the visibility indications for Venus and Mercury. The matter at hand is as follows.

The visibility indication used in the Round Zodiac is a star over the head of a planetary figure, qv below. Mercury, which we see very close to the circle with the young woman, has a star over its head, which means that the planet in question was visible that day. However, in that case Venus should be visible as well, since it is drawn considerably further away from the circle with the young woman, qv in fig. 15.50. The further

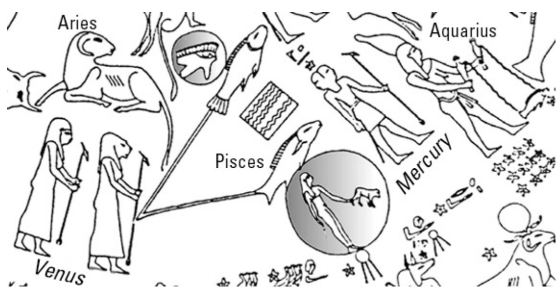


Fig. 15.50. The Round Zodiac of Dendera (DR). Two circles near Pisces are shaded grey; one (with an eye inside) is located between Pisces and Aries, and the other (with a young woman) is in between Pisces and Aquarius. According to our research, both these circles represent the Sun – once in the primary horoscope, where the Sun had been near the star known as "the eye of the Ram" (the Alpha of Aries), and once more in the secondary horoscope of spring equinox. The solution that we came up with tells us that the young woman inside the circle is Venus, which was the closest planet to the Sun on the day of spring equinox (see the section on the dating of the Round Zodiac). Based on the drawn copy of the Round Zodiac of Dendera from [1062], page 71.

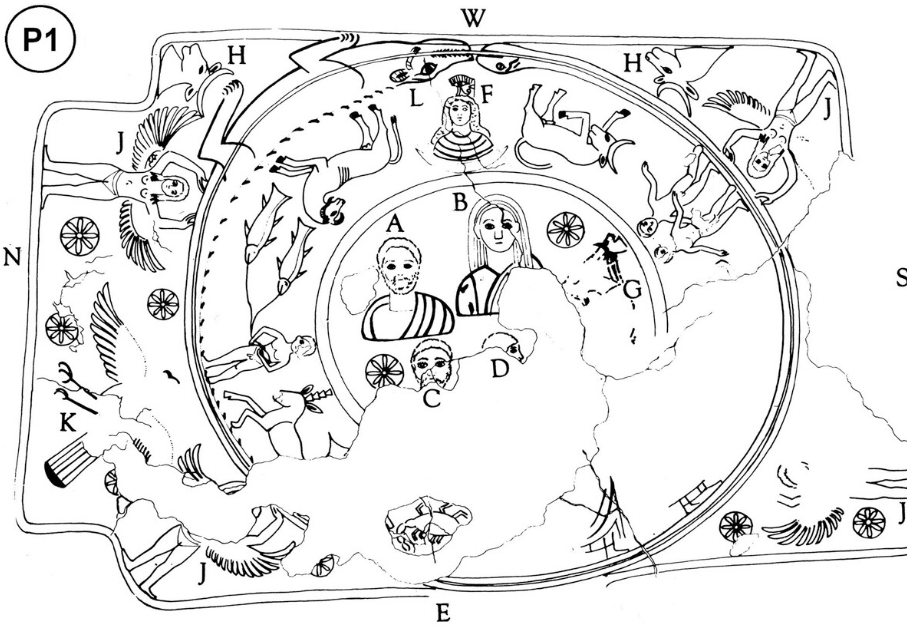


Fig. 15.51. Zodiac P1 from the outer chamber of the Petosiris tomb in Egypt. Drawn copy from [1291], Tafel 39.

the planet is from the Sun, the better its visibility. However, there is no star over the head of Venus in the Round Zodiac. This also implies its invisibility due to proximity to the Sun, qv below and also in [544], Volume 6. We are simply left with no other choice here; the other circle (the one that contains the eye) has to be identified as the Sun, which makes everything look sensible. Venus, being close to the Sun, is depicted with no star over its head due to being invisible, whereas Mercury is further away from the Sun and has therefore got a star over its head.

Quite naturally, these ruminations are of a preliminary nature. The final conclusion in re the visibility of planets can only be made as a result of astronomical calculations, when their position in relation to the Sun shall be identified with precision. Apart from that, astronomical calculations must confirm the very fact that the Egyptian zodiacs contain symbols of planetary visibility. So far this is but a hypothesis of N. A. Morozov that he voiced in [544], Volume 6.

We have done all of it, and the preliminary considerations that we voiced above were confirmed perfectly. Apart from that, it turns out that the interpretations of the Round Zodiac where the eye stands for the Moon, are also invalid insofar as secondary horoscopes are concerned. We therefore had to reject this version and identify the circle with the eye as the Sun. This gave us a solution for the Round Zodiac that proves to be ideal in its every parameter. A propos, the second circle (with the young woman) also turned out to be a solar symbol and not a lunar one as N. A. Morozov had thought. It belongs in a secondary horoscope, though, and not the primary. See more on this below, in the section about the dating of the Round Zodiac.

One has to say that in various works on the dating of the Round Zodiac the circle between Pisces and Aries with an eye inside it would be identified differently. N. A. Morozov ([544], Volume 6) as well as N. S. Kellin and D. V. Denisenko ([376]) presumed it to refer to the Sun. N. A. Morozov accounted for planetary visibility indicators in his analysis, whereas T. N. Fomenko identifies the "Egyptian eye" from the Round Zodiac as the Moon in [912:3], without considering the planetary visibility indicators at all. The other circle in Pisces (with a young woman inside it) is correctly identified as the Sun in this work.

The Egyptologist S. Cauville considers the circle

with an eye from the Round Zodiac to be a symbol of a lunar eclipse, thus linking the Egyptian "eye" symbol with the Moon (see [1062], page 38). Planetary visibility indicators are left beyond consideration in [1062]; the work also identifies Venus falsely, qv above. We already expounded this issue at length, though – the dating that she suggests cannot be considered satisfactory to any degree at all from the astronomical point of view; there are too many far-fetched considerations in this "solution" that invalidate it completely.

Let us point out that the Egyptian "eye" symbol in Egyptology (also known as "the eye of Udiet", qv in [370], [page 17]) was considered to be a symbol of Osiris, among other things ([2], page 2). Osiris, in turn, had associations with both the Moon ([544], Volume 6, page 787) and the Sun (Ra-Osiris, see [532], page 419) in astronomical tradition and symbolism. In the ***Concise Dictionary of Egyptian Archaeology*** by M. Brodrick and A. Morton ([1051:1]) we can read the following in re this symbol: "The holy eye, or *the eye of Ra,* or the celestial eye, refer to the Sun … however, one usually draws two eyes called the eyes of Horus (left and right). Sometimes the right one is used to indicate the Sun whereas the left one stands for the Moon, but they can also be used in a different meaning … the Egyptian name of this eye is Uzat or Utchat ([1051:1], page 54).

However, one could also suggest another interpretation of the Egyptian "eye" symbol – at least, in the cases when it appeared as a planetary attribute in an Egyptian zodiac. Let us point out the fact that in all of the Egyptian zodiacs known to us the "eye" symbol only stands for a planet twice – once in the Round Zodiac of Dendera, and once more in the P1 zodiac from the outer chamber of Petosiris, both times *near the sign of Aries.* Thus, in the Round Zodiac the "Egyptian eye" is located in the circle between Pisces and Aries, and in the P1 zodiac we see it over the head of the young woman that represents the Moon between the signs of Aries and Taurus, qv in fig. 15.51.

However, the star called "Eye", or "Ram's Eye", that was quite famous in ancient astronomy, was located in Aries! It is the Alpha of Aries, the brightest star in a constellation. It is therefore possible that the drawing of an eye in the Egyptian zodiacs isn't so much related to the planet itself (the Sun or the Moon) as the fact that the planet was near the "Ram's Eye" on the date ciphered in the horoscope.

Another circumstance that we must point out in this respect is the Latin word "ram", which means the same in English and implies a certain similarity between the terms "ram's eye" and "the eye of Ra". Furthermore, it is known that Aries, or Ram, was often accompanied by the god Amon (or Amen) in Egyptian symbolism (see [1118:1]), whose name one "more often encounters "in conjunction with that of Ra than separately" ([1051:1], page 7). However, this simply means that "Ram's Eye" and "The Eye of Ra" (or Amon-Ra) are different versions of the same name. Another thing that we need to mention in this respect is the fact that another Egyptian name of this symbol is *Utchat* ([1051:1], page 54), which sounds conspicuously similar to the Church Slavonic word *ovcha,* also meaning "ram".

In zodiac P1 the "eye" symbol is atop the head of the young woman that represents the Moon; this circumstance is conveyed explicitly by the crescent that we see under her portrait in fig. 15.51 (see also fig. 15.47 (P1)).

Thus, the "eye of Ra" from the Egyptian zodiac was most likely to stand for the Sun or the Moon in the vicinity of the star called "Ram's Eye" (the Alpha of Aries).

4.15. The Moon in the primary horoscope

In fig. 15.52 one sees drawings of the Moon from the primary horoscope of an Egyptian zodiac. The grey circles, as usual, contain indications of the zodiacs for which we considered several possible identification options in the primary horoscope. The final solution represented in fig. 15.52 was chosen as a result of astronomical calculations testing the correspondence to secondary zodiacs. See more on how this was done below, in the sections on the dating of individual zodiacs.

The easiest identification case is when the Moon is represented in the drawing by a clearly visible crescent, as is the case in the zodiacs of Athribis, for instance (AV and AN) or the "Coloured Theban" zodiac (OU), qv in fig. 15.52 (AV, AN and OU). There are no doubts that this crescent explicitly stands for the Moon.

It is somewhat more difficult to identify the Moon in those of the Egyptian zodiacs where its symbolism is identical, or almost identical, to that of the Sun. In the Lesser Zodiac of Esna (EM), for instance, both the Sun and the Moon are drawn in the exact same manner – a circle with a crescent at one of its edges. As we already mentioned above, the solar circle might have contained a narrow crescent near the edge to symbolise the fact that a narrow lunar crescent is always close to the Sun. However, the Moon could also be represented by this symbol, in which case we have to consider both versions equal. The final choice between them is made depending on how the identifications correlate to the secondary horoscopes of the zodiac in question.

Let us now discuss the symbol used for the Moon in the Zodiacs of Dendera. We have discussed it in detail above – let us merely provide the readers with a brief reminder.

It has to be said that the lunar symbol in the Zodiacs of Dendera was only estimated with exactitude as a result of extensive calculations which involved all figures that could possibly represent the Moon. However, after we have verified the solutions by secondary horoscopes, which are especially rich in astronomical content on the zodiacs of Dendera, it turned out that it is just a single satisfactory identification of the Moon.

The symbol of the Moon as discovered by the authors in the Dendera zodiacs proved rather unexpected, since it was always considered part of the constellation figure for Libra. It appears that none of our predecessors deemed it to represent either the Moon or any other planet. As we are beginning to understand now, the reason is that none of our predecessors who have studied the zodiacs of Dendera could conceive of the fact that apart from the primary horoscope, one also finds a number of secondary ones therein – also considering the fact that in one of the secondary horoscopes of the Dendera zodiacs (that of the spring equinox) the Sun is drawn in the exact same manner as it is in the primary horoscope, qv in fig. 15.50. This would confuse the researchers who had thought there was but a single horoscope in each zodiac and therefore always mistook one of these suns for the Moon, whereas the real Moon symbol would be declared to stand for "the goddess of Justice", "Hercules" etc, and considered part of the constellation figure representing Libra.

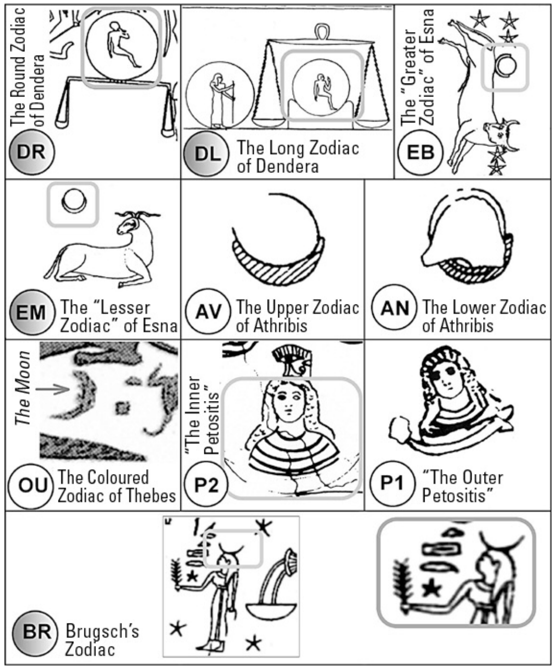


Fig. 15.52. The Moon in the primary horoscope of various Egyptian zodiacs. Cells with grey circles refer to calculated identifications of the Moon with all possible versions of identification taken into account. Fragments taken from [1100], [1291] and [1062].

At the beginning of our study of the Dendera zodiacs we were also certain that the circle in Libra was part of the Libra constellation figure. However, calculations demonstrated this to be incorrect.

It turns out that N. A. Morozov had erred when he wrote that "one finds a circle enclosing the goddess of Justice over the constellation of Libra" ([544], Volume 6, page 658). Morozov neither explains why this should be a "goddess", nor the reason this "goddess" should be one of "justice" – one might guess that the balance scale symbolising Libra and also justice led Morozov to this conclusion. This hypothesis may well exist – however, it requires research and verification. Let us point out that we find no "goddess of Justice" in Libra on any other Egyptian zodiac.

Also, as we already mentioned above, it is most odd that this alleged "goddess of Justice" should be

drawn naked, and with a finger in her mouth on top of that – as an infant, in other words, qv in fig. 15.52 (DR and DL). However, there is no known goddess of Justice considered to be an infant in any mythology.

Let us further point out that a similar naked figure with a finger in its mouth can be seen on the Long Zodiac of Dendera, standing for the *new moon* this time, which is pointed out by N. A. Morozov himself. He writes that "… the girl in front has the Moon over her head. The young age is conveyed by the lack of breasts and the hand held in the mouth" ([544], Volume 6, page 658). Indeed, we see a lunar circle with a distinct crescent inside it. We already cited the lunar figure from the Long Zodiac above in fig. 14.3.

The infantine symbol is most natural for the Moon, unlike the "goddess of Justice". The moon can be "newborn" at times, and we still refer to it as the "new moon", "young moon" etc, which isn't the case with any other planet or star.

To conclude the lunar topic for the constellation of Libra in the Dendera Zodiacs, let us point out the fact that Morozov's reference to the circle on the balance scale of Libra being a frequent occurrence in other ancient zodiac and therefore "unable to serve as a horoscope indication" ([544], Volume 6, page 697), allegedly being a mere part of the Libra constellation symbol instead, is hardly to be believed for the following reasons.

Firstly, the Passover full moon often takes place in Libra – as we shall see, it would occasionally be indicated as such in the old Egyptian zodiacs. This could result in an additional circle drawn in Libra, one that didn't refer to the primary horoscope. However, the example of the Dendera Zodiacs demonstrates that the circle in Libra can also serve as a part of the primary horoscope.

Secondly, even if a certain zodiac contains a circle in Libra that serves as a simple embellishment and doesn't stand for any planet, it doesn't imply the same to be the case with all the other zodiacs. Let us clarify. It is possible that some of the symbols on the most famous Egyptian zodiacs that were the most successful from the artistic point of view and served as examples for the subsequent generations of artists could indeed become "collated" with the constellation symbols over the course of time, forming a unified hieroglyphic symbol. The lunar circle, for instance, which fits the constellation symbol of Libra in the Round Zodiac of Dendera particularly well, could have transformed into a symbol that only pertained to Libra eventually, with no more references made to the Moon. This is possible. However, when we deal with the dating of an actual zodiac, it would be wrong to make the a priori assumption that the zodiac in question has "embellishments" of this kind. Whether or not this is the case can only be demonstrated by calculations that account for all possible identification options of a given zodiac.

The day of the week consecrated to the Moon is Monday, or the second day counting from Sunday. Its Latin name is *Dies Lunae,* which stands for "the day of the Moon" ([393], page 41).

5. PLANETARY SYMBOLS IN SECONDARY HOROSCOPES

"Ancient" Egyptian planetary symbols from the secondary horoscopes are usually significantly different from the way the very same planets are drawn in the primary horoscope. This is perfectly understandable, since otherwise we'd have a perfect hodgepodge of symbols in the zodiacs that would make us unable to decipher the date that the zodiac in question was compiled for. It is obvious that the "ancient" Egyptian astronomers and artists would try their best to evade such confusion when they compiled the zodiacs, and succeed for the most part. As a rule, the planets from the secondary horoscopes are drawn in such a way that one cannot confuse them for the ones related to the primary horoscope.

Let us remind the reader that all the secondary horoscopes of the Egyptian zodiacs are related to the solstice and equinox points. The implication is that they should invariably be located within the confines of the same set of four zodiacal constellations where the Sun is found on the days of solstices and equinoxes. The equinox and solstice points in this case are the solar positions on the Zodiac for such days. Also bear in mind that these points shift across the ecliptic (or the Zodiac) over the course of time. This process is a very slow one, and it takes these points several centuries to move from one constellation to another. It is therefore little wonder that in every

Egyptian zodiac that we studied the autumn equinox point is always located in Virgo, the winter solstice point in Sagittarius, the spring equinox point in Pisces and the summer solstice point, the last one in an Egyptian year, is always in Gemini.

This constant relation between each of the four secondary horoscopes and a single zodiacal constellation would define the way the horoscopes are drawn in Egyptian zodiacs to a great extent. For example, the planetary figures would often be drawn as a whole with the respective constellation figures, initially seeming to be secondary and insubstantial details of the latter. Such details could get easily confused with parts of actual constellation figures.

This would indeed prove the case with all of the numerous researchers who studied the Egyptian zodiacs, none of which managed to notice the presence of secondary horoscopes in any of the zodiacs, their symbolism being different from that of the primary horoscope and following rules of its own. This could result from the fact that every horoscope would usually be studied individually, while the symbolism of the secondary horoscopes requires a comparative analysis of several zodiacs for interpretation. Only then does one see that some of the initially incomprehensible "ancient" Egyptian symbols are anything but chaotic in the way they are distributed across the zodiacs. We conducted further analysis in this field and came up with the unambiguous corollary that one finds secondary horoscopes for equinox and solstice points in Egyptian zodiacs, apart from the primary horoscope. This is the case with nearly every single horoscope from Egypt, and not just one or two of the more "exotic" ones.

We shall refrain from compiling detailed planetary symbolism tables for the secondary horoscopes the way we did above for the case of the primary horoscopes. This task is far from easy – first and foremost, due to a much greater diversity in the secondary horoscope symbols as compared to those of the primary horoscopes. It is also rather difficult to discuss many of these planetary symbols out of the context of the constellation symbols since, as we have just mentioned, they were drawn as parts of the latter. Therefore we shall just begin our discussion of planetary symbols from the secondary zodiacs in the present section, and keep coming back to it in the future – in particular, in the section concerned with the Egyptian symbols used for the solstice and equinox points. Apart from that, we shall provide detailed accounts of the planets from the secondary zodiacs in the sections concerned with the decipherment and dating of actual zodiacs.

For the time being, we shall merely provide the reader with several examples in order to illustrate the way the planetary symbols are drawn in secondary horoscopes in general. One of such examples is the winter solstice horoscope in the Round Zodiac of Dendera. The symbolism of this zodiac has already been discussed at length in literature, qv in [544], Volume 6; also [1062], [1062:1] and [913:3] and the references from the works in question. Our interpretation of these symbols is quite novel, though.

5.1. The first example: the planets from the secondary horoscope of autumn equinox in zodiac DL

In fig. 15.53 one sees a part of the Long Zodiac of Dendera (DL) surrounding the figure of the Virgo constellation. The autumn equinox horoscope would be drawn in Virgo by the Egyptian artists and astronomers. We find such a horoscope in the Long Zodiac as well.

In order to decipher the astronomical meaning of the Egyptian symbols that one sees in fig. 15.53, let us first recollect the fact that in the Long Zodiac of Dendera each constellation is represented as three "ten-grade" figures simultaneously, qv in Chron3, Chapter 15:2.1. One of these figures is the actual constellation figure, whereas the two others look like young women, which are identical throughout the entire zodiac. All of the figures as a whole stand for the three ten-degree thirds of the constellation in question. N. A. Morozov was the first to use the term "ten-degree figures" in [544], Volume 6, due to the fact that a third of a zodiacal constellation takes up roughly ten degrees of the ecliptic on the average.

The figure used for representing the Virgo constellation in the Long Zodiac looks like a young woman with an ear of wheat in her hand, qv in fig. 15.53. Let us reiterate that this is the most usual way of drawing this constellation – not just in the Egyptian zodiacs, but also the mediaeval European ones. Both of the

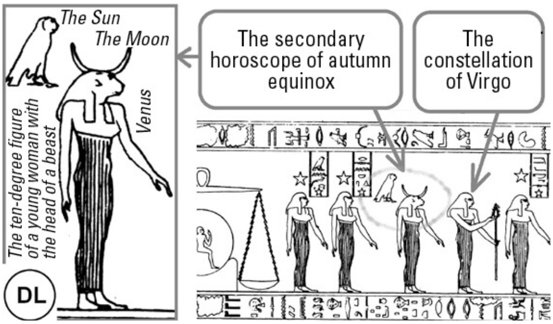


Fig. 15.53. Drawings of the planets (the Sun, the Moon and Venus) in the secondary horoscope of autumn equinox of the Long Zodiac (DL). Here we see the symbols of planets that were close to the Sun on the day of the autumn equinox integrated into the second ten-degree figure of Virgo. It is the ten-degree figure of a young woman with the head of a beast (lioness?) and a crescent on her head, following Virgo immediately. The lioness is an Egyptian symbol of Venus. The crescent is a lunar symbol here. The Sun on the day of the autumn equinox is represented as a bird over the shoulder of this ten-degree figure of a young woman. The solar bird also has a leonine head, according to the drawn copy. Fragment of a drawn copy taken from [1100], A. Vol. IV, Pl. 20.

ten-degree figures of young women follow her, qv in fig. 15.53. Thus, the figure of Virgo also represents the constellation's first third, followed by the second and the third indicated by the "ten-degree figures" drawn as young women. The following figures pertain to Libra already.

The entire secondary horoscope of the autumn equinox is concentrated around the second ten-degree figure of Virgo. In fig. 15.53 it is the young woman that follows the actual constellation figure immediately. One can instantly notice a certain odd quality about this particular young woman's figure that makes it different from the ones drawn elsewhere in the Zodiac, which all look the same. The reason is that its figure includes the planetary symbols from the secondary autumn equinox horoscope, or the planets that could be observed near the Sun on the autumn equinox day of the year that the zodiac was compiled for.

The sun itself is drawn at the autumn equinox point as a bird over the shoulder of the young woman standing for a third of a constellation. Furthermore, we find Venus and the Moon in this secondary horoscope.

Let us begin with Venus. As we already mentioned above in re the symbolism of Venus (see the section on Venus in the primary horoscope), one of the Egyptian symbols used for Venus was a lioness. Venus would often be drawn as a woman with a leonine head in Egyptian zodiacs, qv in fig. 15.39 above. If we take a closer look at the constellation of Virgo in the Long Zodiac, we see that the second ten-degree figure in Virgo has the head of a beast in lieu of a human one, and it resembles a lion a lot (see fig. 15.53). The solar symbol (the bird over the shoulder of the young woman) appears to be drawn with a leonine hear as well, qv in fig. 15.53.

We must point out that this happens to be one of the two unique cases among all the 24 ten-degree female figures found in the Long Zodiac. As a rule, all these figures are drawn with human heads and female faces. We shall jump ahead and mention the second such exception, which is the female ten-degree figure with the head of a falcon that we see between Scorpio and Libra. As we shall witness below, this figure also contains a part of some horoscope – the winter solstice horoscope this time. We shall give a detailed account of it in the following sections.

But let's return to the figure that marks the second third of Virgo. As we see, it is drawn in the Zodiac in almost the same manner as we often find Venus drawn in the primary zodiacs – as a young woman with a leonine head. Mark the fact that this young woman has no planetary rod – otherwise it would be a "fully-fledged" figure of Venus fit for the primary horoscope. This could lead to confusion in the present case – however, the Egyptian artists leave us no leeway for confusion.

What we encounter is a typical example of a planet from a secondary horoscope of an Egyptian zodiac. Such figures often resemble the representations of the same planets in the primary horoscopes, but, in general, they differ from each other to a sufficient extent. Furthermore, the planetary figures from the secondary horoscopes are usually "integrated" into the constellation figure, or whatever symbols one finds nearby. In the present case, the figure representing the second third of Virgo was chosen as the "carrier", which resulted in said figure's transformation into a complex "astronomical hieroglyph" of sorts.

Now let's move on to the Moon. The very same female figure that stands for the second ten-degree fig-

ure of Virgo has a crescent on its head. Once again, this is the only such case for all 24 ten-degree figures of the Long Zodiac – none of the other 23 have a crescent or anything of the kind over their heads. This very crescent represents the Moon in the secondary autumn equinox horoscope and either stands for the Moon on the day of the Equinox, or, possibly, at the moment when the new moon is born, right after the equinox. Let us explain that since the Moon is drawn right next to the Sun here, it could have remained beyond visibility on the day of the autumn equinox. However, it would soon "be born" and appear in the sky as the thin crescent of a new moon near Virgo, which is precisely what we see in this zodiac.

To conclude with our analysis of the example, let us mention the fact that, generally speaking, there is another interpretation option applicable to the horoscope in question. Let us take another look at fig. 15.53. Above we consider the animal head of the female ten-degree figure to be leonine, which should stand for Venus. However, this isn't quite apparent from the drawn copy of the DL zodiac that we use herein. It is also possible that the head in question is bovine, which will lead to a different interpretation of the zodiac, since a bull's head with a crescent stands for the planet Saturn, in the DL zodiac and elsewhere, qv in fig. 15.31 above.

Therefore, it is theoretically possible to interpret this secondary horoscope differently, as Saturn and the Sun both being in Virgo on the day of the autumn equinox. In this interpretation, the crescent over the head of the ten-degree female figure will symbolise Saturn and not the Moon. Venus, which is always found near the Sun in the secondary horoscopes due to its proximity thereto, won't remain sans identification in this case, either – it could be symbolized by the leonine head of the bird that represents the Sun, qv in fig. 15.31.

However, such an interpretation is impossible in the present case, since it contradicts the position of Saturn in the primary horoscope of the DL zodiac. The matter is that Saturn moves very slowly, and couldn't have drifted too far away from its position in the primary horoscope over the course of a single year. Therefore, the position of Saturn in any secondary horoscope must be roughly the same as it is in the primary. However, in the DL zodiac Saturn is drawn at a great distance from Virgo, being near Aquarius and Capricorn. Therefore, a secondary horoscope with Saturn in Virgo shall yield no astronomical solutions that would concur with the primary horoscope.

In other words, the location of Saturn in Virgo in the Long Zodiac is ambiguous from the astronomical point of view; therefore, the second interpretation version of the secondary autumn equinox horoscope can be rejected instantly.

5.2. The second example: planets from the secondary horoscope of winter solstice in the DR zodiac

In fig. 15.54 one sees a drawn copy of a part of the Round Zodiac of Dendera (DR) in the vicinity of Sagittarius. One also sees the constellations that follow Sagittarius, namely, Scorpio and Libra. Let us remind the reader that the secondary horoscopes found in Sagittarius refer to the winter solstice. In the Round Zodiac of Dendera this particular secondary horoscope is extremely detailed.

The actual figure of the Sagittarius constellation that contains the winter solstice point incorporates the symbols of Mercury and Venus. They are represented by the two-faced head of Sagittarius. One of its faces is human (Mercury), and the other leonine (Venus), qv below, in Chapter 15:8.2 of CHRON3.

Apart from that, a part of the Sagittarian horse's tail is facing upwards and there's a goose standing on its end, qv in fig. 15.54. The figure of a goose symbolises Mars in the Egyptian zodiacs; therefore, the secondary horoscope is bound to contain the planet in question.

The very fact that the figure of Sagittarius incorporates planetary symbols is also emphasized by the use of a certain additional "transposition" symbol – the boat under the front legs of the Sagittarian horse, qv in fig. 15.54. Below we shall mention the fact that a boat, or some other symbol one sees under the feet of a given figure, refers to the fact that the figure in question is "transposed" to the location in question from its place in the primary horoscope. Zodiacs of the round type would use the symbols of boats for this purpose, since the use of other figures would lead to congestion and confusion. In particular, whenever we encounter such symbols under planetary figures, it

Fig. 15.54. Secondary horoscope of winter solstice in the Round Zodiac of Dendera (DR). The planets of this secondary horoscope are highlighted. The figure of Sagittarius integrates the symbol of Mercury (the head with two faces). Apart from that, we see a goose above the equine half of the Sagittarian figure – right over its tail. It symbolises Mars, which should therefore be present in this horoscope. The figure on the chair that holds a planetary rod and has got a large circle over its head is sitting in a boat. The latter is a transposition symbol, qv in CHRON3, Chapter 15:6). Thus, we cannot mistake it for the planet of a primary horoscope, despite the obvious planetary rod. The circle over its head may identify it as a solar symbol. Another planet of a secondary horoscope is the tiny figure sitting on a chair over Libra. It is holding a whip in its hands, and there is a figure of an animal underneath the chair – one that looks like a lion or a leopard. Should it prove to be a leonine figure, it shall be identified as a symbol of Venus, qv in CHRON3, Chapter 15:4.8. Thus, we see three planets in the horoscope, one of which might be the Sun, which shall leave us just two of them. Mars should be one of the latter, and the other is likely to be Venus. The drawn copy from [1062], pages 9 and 71, is on the left, and a close-in of a photograph of the DR zodiac is on the right. Photograph taken from [1101], page 255.

means that they don't belong to the primary horoscope. In the present case, the boat we find underneath the Sagittarian symbol tells us that we shouldn't interpret the two faces of Mercury integrated in the constellation figure as the indication of Mercury being in Sagittarius for the primary horoscope. The boat emphasises the fact that the position of Mercury here has got nothing in common with its position in the primary horoscope. First and foremost, the boat figure informs us of the fact that one should look for the secondary horoscope symbols here.

We see three more figures right over Sagittarius. One of them has a planetary rod, but cannot be ascribed to the primary zodiac, since we see it in a boat, which means that it's transposed there from its position in the primary zodiac. The rods of the two other figures aren't of a planetary nature, and resemble a baculus and a whip. Therefore, we cannot ascribe these figures to the primary horoscope, since all of them are explicitly drawn with planetary rods in the Round zodiac.

Since all of the figures in question are concentrated in the vicinity of Sagittarius, or the region of the secondary winter solstice horoscope, they must stand for this horoscope's planets. Let us provide a list (see fig. 15.54).

1) The man carrying a baculus that stands for some "male" planet (any planet but Venus, that is).

2) The figure of a person sitting on a stool, with a circle over its head and a planetary rod in its hand. The stool stands in a boat. The large circle over the figure's head could lead us to identifying said figure as the Sun. However, it could be that the Sun is represented by the circle and nothing else, whereas the sitting figure stands for one of the planets. The boat underneath the figure emphasises the fact that the symbol in question pertains to the secondary horoscope. Thus, what we see here is either the Sun from the secondary zodiac of winter solstice, the Sun and some other planet nearby. It can be any planet at all, since the figure is sitting with its legs drawn together. See Chapter 15:3 of CHRON3 in re the differences between male and female figures as drawn in the Egyptian zodiacs.

Let us point out that in most other Egyptian zodiacs the artists would draw the Sun in the winter solstice horoscope as a mere "solar hat" over the head of Sagittarius/Mercury, or a hat with a circle inside or atop it. They didn't normally draw the Sun as a separate figure here.

3) The little figure on a stool above the constellation of Libra. There is some animal under the stool. It looks like a dog in the drawn copy, but, according to the photograph, it is most likely to be a lion or a leopard, qv in fig. 15.54. The figure may be a female one – however, since it's drawn sitting with its legs to-

gether, one cannot tell for certain. If the animal under the stool is a lioness, and the figure itself female, it should be Venus. Let us remind the reader that a lioness is one of the attributes of Venus in the Egyptian zodiacs, qv in the section on Venus and its symbolism in the primary horoscopes above.

Thus, we see three planets in the horoscope in question apart from the ones integrated into the figure of Sagittarius. However, one of them might stand for the Sun, which was in this position on the day of the winter solstice. There were two or three more planets here, one of them being Mars and another, Venus.

5.3. Third example: planets from the secondary horoscope of summer solstice in the AN zodiac

In fig. 15.55 we see a part of the lower Athribis zodiac AN near the constellations of Libra, Virgo, Cancer, Gemini and Taurus. The figures of all these constellations are easy enough to recognize in the picture – they form the top row of figures, in a way. We see the planetary birds underneath, in fig. 15.55, and another row of symbols below them. We are looking at the secondary horoscope of the summer solstice.

Let us point out that the secondary horoscope of the autumn equinox that should be located somewhere around the constellation of Virgo is missing from the zodiac in question. The symbolism of the entire lower row of figures in fig. 15.55 is explicit enough to tell us that we see the symbols of summer solstice and nothing but – there are no symbols anywhere in the vicinity that would stand for the autumn equinox, for instance. Egyptian zodiacs of average complexity, like the zodiacs of Athribis, could contain just some of the secondary horoscopes and not all of them – just two or three instead of four, for example.

If we take a closer look at the lower row of figures in fig. 15.55, we shall first and foremost see a calf that lays in the boat with a star between its horns. Secondly, we also see the drawing of a man here, whose arm is raised high into the air with five birds with human heads drawn nearby – two of them by one side of the man, and three by the other.

A calf in a boat is a usual Egyptian symbol of summer solstice. We find it on a great many zodiacs. The complete version of this symbol is more complex and can also include a female figure with a bow which is shooting an arrow over the calf's head, qv in the zodiacs DR and EM, for instance. Here we see a simpler version of the symbol. See the section on the symbols of solstices and equinoxes in the Egyptian zodiacs for more details.

The man with his arm raised high into the air is also a very popular symbol of summer solstice that one finds in the Egyptian zodiacs. We have mentioned this symbol above, and will keep coming back to it. Apart from the zodiacs of Athribis, we can see it in the zodiacs DL and EM, for example. Likewise the abovementioned calf, this symbol is only seen in the vicinity of Gemini and the summer equinox point. As we already mentioned, this figure is most likely to symbolise the Sun reaching its top position in the sky.

Thus, we see two Egyptian summer solstice symbols here at once. We see them in the part of the zodiac adjacent to Gemini, which is where the summer solstice point is always located in Egyptian zodiacs.

Let us now find the planetary symbols from the secondary horoscope. It is easy enough to do – bear in mind that planets are drawn as birds in the Athribis zodiacs. Indeed, we see a total of five birds here, all of which possess human heads, qv in fig. 15.55. These must be the secondary horoscope planets that we are looking for. Two of them are by one side of the Sun, and three more on the other. If we are to assume that the drawing reflects the respective positions of the Sun and the planets in question for the day of summer solstice, it makes the conditions for the zodiac's astronomical solution even stricter. It is understand-

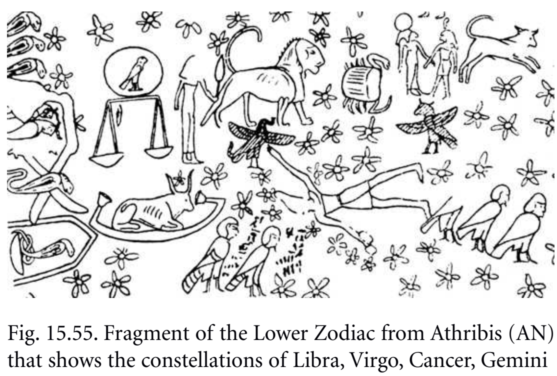


Fig. 15.55. Fragment of the Lower Zodiac from Athribis (AN) that shows the constellations of Libra, Virgo, Cancer, Gemini and Taurus. The figures of these constellations form the top row of the picture. Underneath them we find symbols of the secondary summer solstice horoscope. Fragment of a drawn copy from [1340:1]. Taken from [544], Volume 6, page 730.

able that the possibility of a random erroneous solution to pass through this narrow a doorway becomes all but null.

One could naturally make said "doorway" somewhat wider. For instance, it is possible that Venus and/or Mercury are drawn as a pair of birds each. This will be a rather far-fetched presumption, since Venus and Mercury are drawn as solitary figures in the main horoscopes of both zodiacs from Athribis, AN and AV with no exceptions – we see no evidence to the contrary anywhere. However, the presumption is not to be rejected offhandedly, which leaves us with more interpretation option for the secondary horoscope in question. However, we shall jump ahead somewhat and state that the astronomical solution that we got for the Athribis zodiacs is ideal and corresponds with the primary horoscope perfectly, with no allowances and theorizing whatsoever. We must also mention the fact that, according to our general approach, secondary horoscopes aren't used for the search of astronomical solutions at all and are only used at the stage of verifying the solutions that we came up with using the primary horoscope.

6. BOATS, SNAKES AND OTHER TRANSPOSITION SYMBOLS UNDERNEATH THE FIGURES

A careful study of the Egyptian zodiacs brings us to the following important observation. Some of the figures have no "supporting accessories" underneath them whatsoever – they are simply drawn as objects in the sky (bear in mind that any Egyptian zodiac is a symbolical star chart). Other figures from the very same zodiacs are explicitly drawn as standing on something – either boats, snakes (which are often curved in such a way that they resemble boats) or other objects. One and the same symbol can be drawn without a supporting base in one position on the zodiac, and seen "riding" some object elsewhere (or floating upon said object).

In fig. 15.56 we see a fragment of a drawn copy of the Long Zodiac of Dendera (DL). Among the planetary rod-bearing figures, we see the two that look perfectly the same – male figures with the heads of falcons and planetary rods in their hands. All the indications tell us that we see the same planet. One of such figures can be seen to the left of Aquarius, whilst the other is at a considerable distance from the first figure on the right. There are many other figures between these two, qv in fig. 15.56. Therefore, despite their being absolutely identical to one another, one can hardly consider them to stand for the same planet in the same position. Had this been the case, the figures would be drawn much closer to each other, and located on the same side of Aquarius. They must stand for something else, and we should be able to see the differences in the symbolism used for both – otherwise, the zodiac would be illegible in principle, which definitely wasn't the objective pursued by the Egyptian artists. However, both figures look exactly the same, qv in fig. 15.56.

The matter is that one of them doesn't appear to be standing upon anything special, whereas the other is standing atop the figure of a goose, as if it were using it for a flotation device, qv in fig. 15.56.

One can cite many similar examples. Virtually in every old Egyptian zodiac we see certain objects (not just the planetary symbols) stand on top of other objects, most often boats or snakes, or various animal figures, qv above. Let us cite a fragment of another zodiac – the "Lesser Zodiac of Esna", qv in fig. 15.57. We see a number of figures standing in boats or atop snakes. Another such example that pertains to the zodiacs of Athribis can be seen in fig. 15.58.

The comparative analysis of the Egyptian zodiacal symbolism that we have performed demonstrates all of these boats, snakes, geese and other "daises", or "carriers", possess a very explicit astronomical meaning. They are the "transposition signs" used by the Egyptian artists to indicate that the figure in question isn't standing in its rightful place, being transferred to some other position instead.

The transposition symbols were used very widely in the compilation of the Egyptian zodiacs, and an artful use of them allowed the ancient Egyptian artists and astronomers "cram" several horoscopes into a single zodiac at once – one primary horoscope and up to four secondary ones, and in some cases even several primary horoscopes, which we find to be the case in Brugsch's zodiac (BR). It would suffice to mark the planets of the secondary horoscopes using transposition symbols to avoid confusion with the pri-

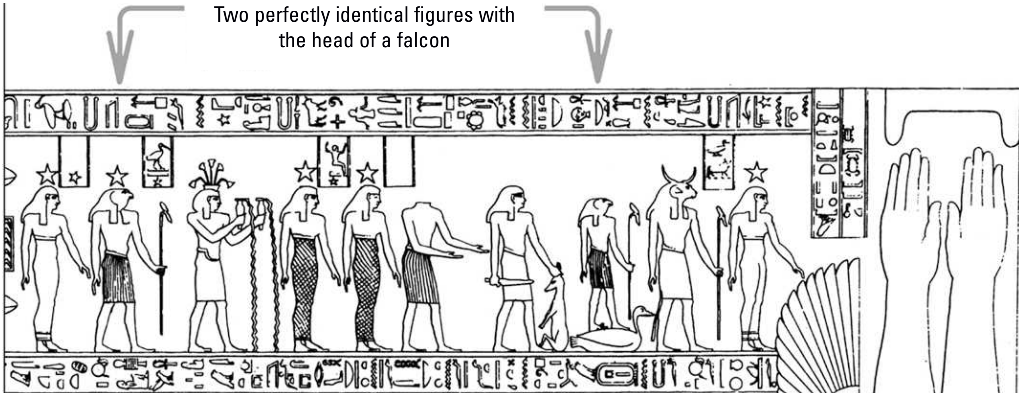


Fig. 15.56. Fragment of the Long Zodiac (DL). Here we see two perfectly identical planetary figures (looking like a man with the head of a falcon) on the left and right of the Aquarius sign (man pouring water from two pitchers). In other words, the two are separated by too great a distance, and therefore cannot possibly refer to the same planet in the same position. The only difference between them is that one of the figures is drawn walking, and the other one is riding a goose. The goose under the feet of the second figure is a "transposition symbol" which means that the planet in question is drawn in a different place than it occupies in the primary zodiac. It passed the location in question on a different day – not the one transcribed in the primary zodiac. These methods allowed Egyptian artists to draw several horoscopes that referred to various points in time and astronomical situations in the same zodiac without any confusion symbol-wise. Fragment taken from [1100], A. Vol. IV, Pl. 20.

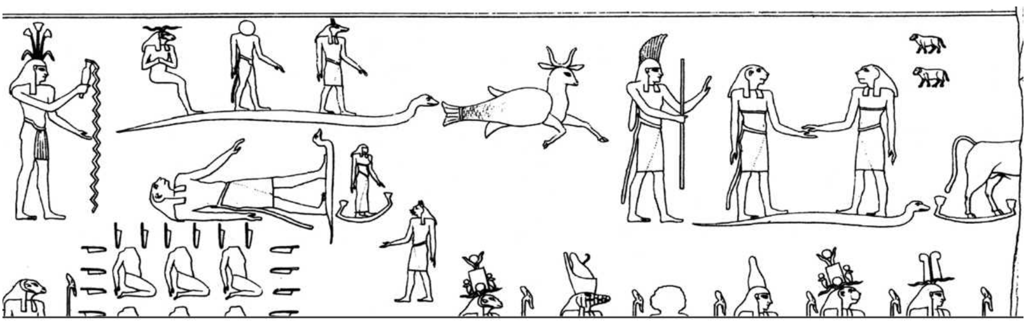


Fig. 15.57. Fragment of the EM zodiac from the Lesser Temple of Esna. Here we see many figures "floating" in the sky on snakes or in boats. Taken from [1100], A. Vol. I, Pl. 87.

mary horoscope's planets. Thus, the method in question would allow them to use the same symbol for the primary and the secondary horoscope and be able to distinguish between the two. As for the confusion between the secondary horoscope's planets, it would be minimal due to the fact that each secondary horoscope is rigidly affixed to one and the same position on the ecliptic, namely, the respective solstice or equinox point. Therefore it is usually easy enough to determine the identity of a secondary horoscope planet.

Apart from that, the "transposition" method would allow the Egyptian artists to distribute zodiacal figures across the entire field of the drawing – for instance, to transpose some of the figures from their rightful positions which are too cluttered-up by other figures. All it took was a transposition symbol and drawing the figure in such a way that its proper position would be obvious. This is the method used for the spring equinox symbol in the EM zodiac. We shall discuss this in detail below, in the section on the dating of the EM zodiac.

It has to be said that the meaning of the boat symbols in the Egyptian zodiacs as symbols modifying the meaning of the figures found in boats was pointed out

Fig. 15.58. Fragment of the perimeter strip with figures from the Upper Zodiac of Athribis (AV). Here we see a star in a boat next to the planetary symbol with a rod. The boat is formed by the curve of a serpent's body. The most probable meaning of the symbol is that the figure in question (Mercury) isn't drawn in the primary horoscope; this must be exactly why we see a star next to the planet – the same planet in a boat. Boats served as "transposition symbols" in Egyptian zodiacs. Fragment of a drawn copy from [1340:1]. Taken from [544], Vol. 6, page 730.

for the first time by T. N. Fomenko in her recent publication on the interpretation and the dating of the zodiacs from Dendera and Esna ([912:3]). Earlier researchers of the Egyptian zodiacs didn't ascribe any astronomical meaning to these symbols whatsoever.

7. VISIBILITY INDICATORS OF THE PRIMARY HOROSCOPE'S PLANETS

When the Sun is shining in the sky, sunlight renders the stars and the planets invisible. We can only see bright stars when the Sun is some 10 arc degrees below the horizon, naturally counted in the direction perpendicular to the horizon and not the visible trajectory of the Sun. In the moderate latitudes the stars and the planets become visible about one hour after sunset, and cease to be visible when there's about the same amount of time left until the edge of the Sun emerges from beyond the horizon. The further to the south, the less this period of time. It roughly equals 40 minutes near the Equator, which is the time it takes the Sun to cover a ten-degree arc in the course of its movement along the ecliptic. The reason is that in the South the angle between the Sun and the horizon is closer to 90 degrees, which is why dusk and dawn come quicker than in the north.

While the Sun remains within the limits of ten degrees below the horizon, it is daytime or a bright enough twilight. We see no stars or planets, excepting the Moon. Venus and some of the brighter stars can also be an exception. They are visible when the Sun hasn't set all that far below the horizon – however, it has to be some 7-8 degrees below the horizon for us to see any planets at all. Let us also point out that the luminosity of planets alters significantly over the course of time due to the fact that they reflect the light of the Sun, and their luminosity as observed from the Earth is determined by how much their illuminated part is turned towards the Earth, among other things. This is the case with the Moon; however, due to the smaller size of the planets, we can't always tell that they look like crescents when we observe them with the naked eye. The fastest and most observable luminosity shifts are characteristic for the inner planets, Mercury and Venus.

Therefore, if one planet or another gets too close to the Sun in its visible motion, it disappears from sight. This can take place in the following manner: day after day, the planet rises closer to the dawn, then only appears for a few brief moments before sunrise, and, finally, disappears from sight altogether. A few days later it re-appears at dusk. The reverse sequence is also possible, when a planet disappears from sight at dusk and becomes visible again at dawn.

External planets (Jupiter, Saturn and Mars), whose orbital radiuses are greater than that of the Earth, disappear from sight relatively rarely, qv in fig. 14.20, for instance, where we use a randomly-chosen year to illustrate the motion of the Sun and the planets as seen from the Earth. Unlike the external planets, Venus and Mercury disappear from sight several times each year, which would often make them invisible in the primary horoscope of a given Egyptian zodiac. This was pointed out by N. A. Morozov, who had discovered that the visibility or invisibility of a given planet would be meticulously indicated in the Egyptian zodiacs. For instance, in the zodiacs of Dendera, such indicators are drawn as stars near the heads of the planetary figures ([544], Volume 6, pages 675, 678 and 679).

We have verified this hypothesis of N. A. Morozov, and it turned out to be perfectly true. The visibility or invisibility of a given planet would indeed be indicated in the Egyptian zodiacs, all the more meticulously for the planets which are close to the Sun (let us remind the reader that only such planets could be

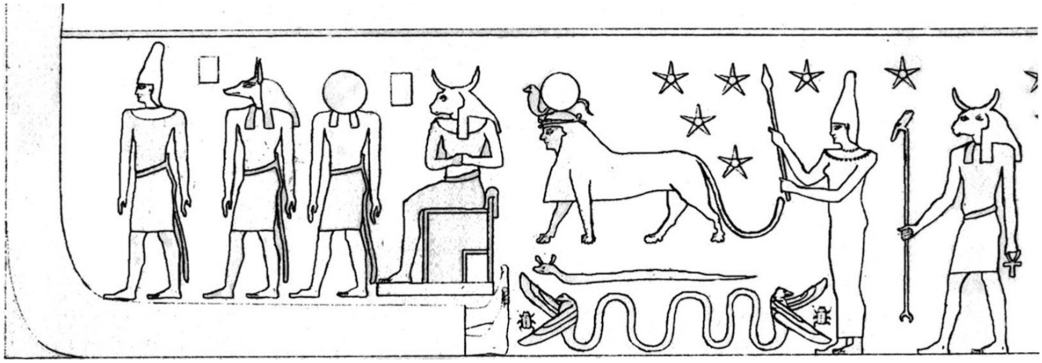


Fig. 15.59. Planetary visibility/invisibility indicators in the EB zodiac from the Greater Temple of Esna. We see a fragment of the zodiac with Virgo and its vicinity. In particular, one sees the secondary horoscope of autumn equinox here (planetary figures have no staves in this horoscope). In the left of the picture one sees three male figures. One of them has got a circle instead of a head, which symbolises the solar disc that "obscured" the planet in question, making it invisible. The other two planets were visible. The other solar disc over the head of the lion with a human face (Venus in a secondary horoscope) also refers to the invisibility of a planet caused by bright sunshine. Taken from [1100], A. Vol. I, Pl. 79.

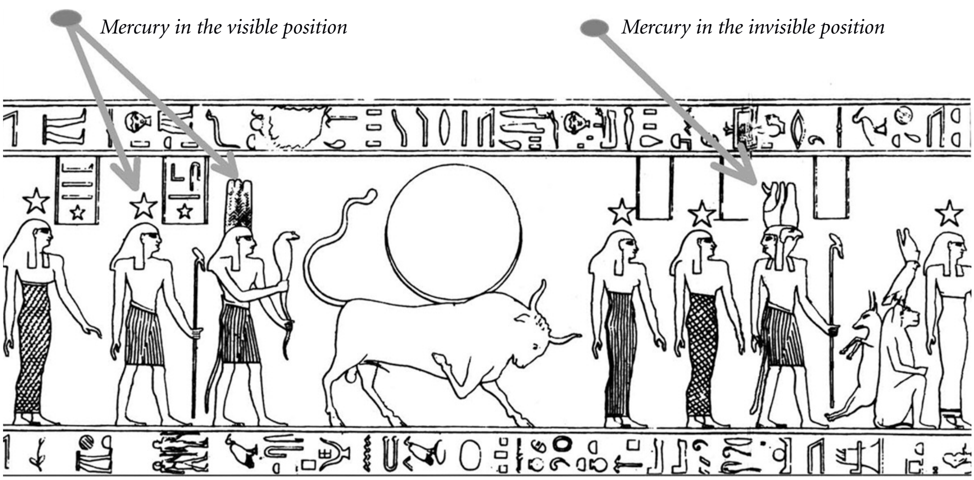


Fig. 15.60. Fragment of the Long Zodiac (DL) depicting Taurus and the surrounding area. We see a figure of Mercury on either side of the constellation symbol, represented in two positions – visible and invisible. The visible position of Mercury is marked by a visibility indicator, namely, the star over the head of the figure on the left. The invisible position of Mercury is at great temporal proximity, so it also entered the primary horoscope as the two-faced planetary figure without any star. Taken from [1100], A. Vol. IV, Pl. 20.

invisible). These indicators could become omitted for the planets at a distance from the Sun, since their very position in relation to the solar would make them visible by default. Nevertheless, visibility indicators are given for the planets located at a greater distance from the Sun as well.

These visibility indicators would most often attain the shape of stars near the heads of the planetary figures, which is the case with the Zodiacs of Dendera. However, in some cases other indicators were also used. In the EB zodiac from the Greater Temple of Esna, for instance, we find invisibility indicators instead – namely, the figures of the invisible planets would have a solar disc over their heads or instead of them. The symbolism is perfectly clear – the planet is invisible because the Sun "obscures its face".

Let us point out that the use of such symbolism indicates good understanding of the true nature of the process and its mechanism.

Visibility and invisibility indicators are usually just found in the primary horoscopes of the Egyptian zodiacs – however, one occasionally finds them in the secondary zodiacs as well. This is the case with the "Greater Zodiac of Esna" (EB), for instance. We can see a fragment of this zodiac in fig. 15.59 with the secondary horoscope of the autumn equinox. There are three male figures on the left of the picture, and they stand for the planets of the secondary horoscope in question (we must point out that the planetary figures have no rods in the EB zodiac). One of the three figures has a solar disc instead of its head, which means that the planet in question was invisible.

As we have already mentioned, Mercury could occasionally assume both positions over the course of time ciphered in a given zodiac, which could be an interval of several days. In such cases it could be drawn twice – once in the visible position, and once more in the invisible. This is the situation with the Long Zodiac of Dendera, qv in fig. 15.60.

In our research we accounted for planetary visibility indicators as well as the secondary horoscopes. It turns out that there is a precise astronomical solution for each of the Egyptian zodiacs that we studied, one that satisfies to the specifications set by the primary horoscope as well as secondary horoscopes and visibility indicators. This is why we claim Morozov's hypothesis about the visibility indicators to have been confirmed completely. Had the opposite been the case, we wouldn't have been able to find such solutions for each horoscope that we studied, without exception.

8. EQUINOX AND SOLSTICE SYMBOLS

Equinox and solstice points are represented by means of special symbols in Egyptian zodiacs. We have deciphered the solstice and equinox symbolism in the course of our analysis of Egyptian zodiac. This symbolism is characterized by very high stability: it is encountered in different kinds of zodiacs without alterations. Therefore, the equinox and solstice symbols can be classified as the most easily legible symbols of the Egyptian zodiacs. There are usually no problems of any sort with their decipherment.

Equinox and solstice symbols are of paramount importance for astronomical dating. They mark the locations of secondary horoscopes in Egyptian zodiacs. Therefore, the correct interpretation of symbols is still vital for the astronomical analysis of zodiacs. It has to be said that some of these symbols are still interpreted completely erroneously in Egyptologist literature. We shall cite a few examples of such interpretations shortly.

Above we have already mentioned some of the equinox and solstice symbols as found in Egyptian zodiacs. We shall now consider them in greater depth.

8.1. Autumn equinox symbols in Virgo

In fig. 15.61 we see Egyptian signs and figures that relate to the autumn equinox point. These symbols are always drawn in the same place of any Egyptian zodiac – the vicinity of Virgo, which is where the autumn equinox point is located. Some of them may also refer to the symmetrical vernal equinox point, and, consequently, turn up in the region of Pisces.

Let us provide a list of said symbols.

1) Human figure holding a small child in one hand and making a benediction gesture with the other. This symbol is found in the autumn equinox point on both Dendera zodiacs – the Round and the Long, qv in fig. 15.61 (DR and DL). The meaning of these symbols becomes clear if we are to remember that the Egyptian year started in September, around the day of autumn equinox ([544], Volume 6, page 641). It is possibly that the infant figure symbolises the New Year – very young, "newly born", as it were.

2) Rectangular tablet with some semblance of lettering. In reality, there is no lettering; however, there are wavy lines on the tablet that appear to stand for inscriptions. Two such tablets are present in the Round Zodiac of Dendera – in the points of autumn and spring equinox. A leonine figure reclines against the tablet that marks the point of autumn equinox – this might be a reference to the constellation of Leo, whence the Sun comes to the point of autumn equinox. In general, equinox symbols in Egyptian zodiacs would sometimes include drawings of neighbouring constellations – Leo for autumn equinox and

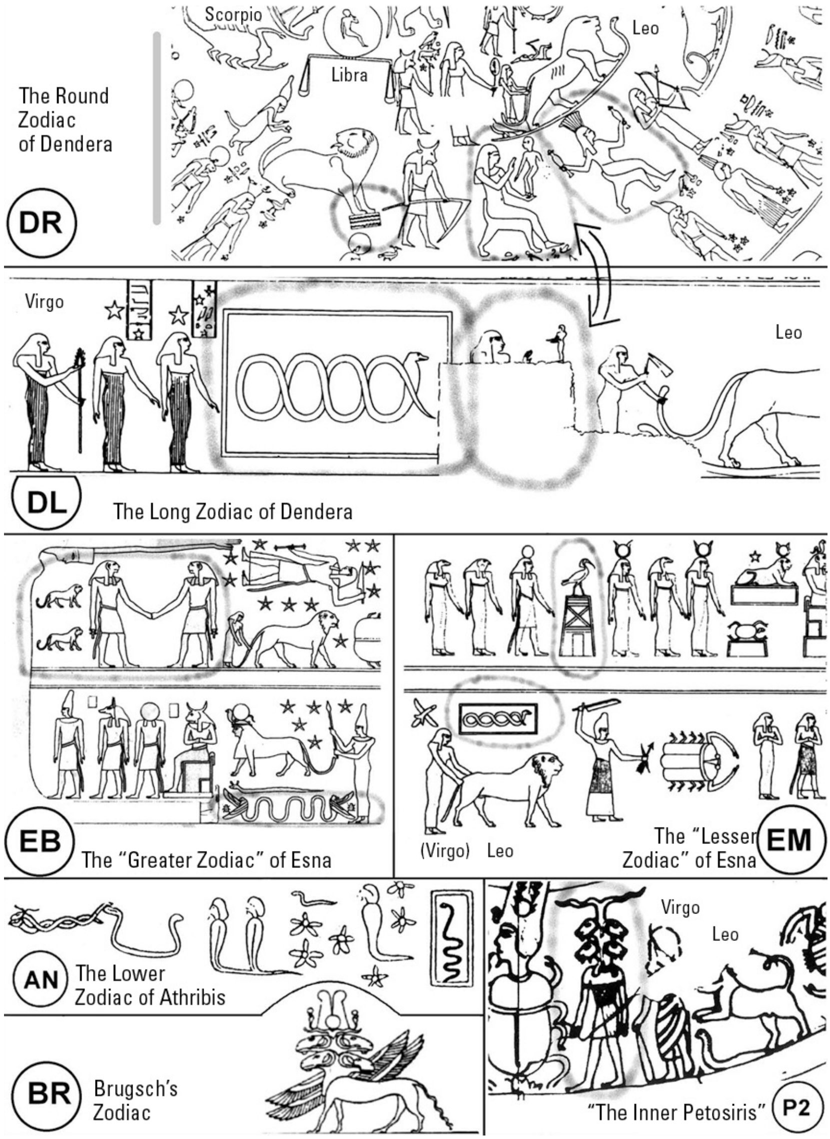


Fig. 15.61. Autumn equinox symbols in various Egyptian zodiacs. Taken from [1100], [1062] and [544], Volume 6.

Aries for vernal equinox (see zodiacs DR, EB and EM, for instance).

These tablets were pointed out by N. A. Morozov, who was perfectly right to point out that they mark the equinox points on the Round Zodiac ([544], Volume 6, page 658). See fig. 15.61 (DR and DL).

3) Crowned human figure sitting on a chair, symmetrically holding two identical sceptres or vessels in both hands (see fig 15.61 – DR). Apparently, the symbol refers to the equality of day and night. The figure appears to be weighing two jugs (or sceptres), finding them to be of equal weight – they symbolise the equal durations of day and night. We have only encountered this symbol once – in the Round Zodiac of Dendera, qv in fig. 15.61 (DR).

4) The snake whose body is woven into a double

figure of eight. The symbol can be seen on several zodiacs, always right in the point of the autumn equinox. Out of the zodiacs that we have studied, it can be seen in the Long Zodiac of Dendera (DL), the Lesser Zodiac of Esna (EM) and the Lower Zodiac of Athribis (AN, fig. 15.61 – DL, EM and AN).

5) Symmetrical convoluted body of a snake with two identical cobra heads, one on each end. Sometimes the "symmetrical snake" would also have two identical pairs of wings with a tiny beetle in between, the symmetry of the symbol remaining intact.

Such symbols can be found in points of autumn and vernal equinox. The autumnal variety can be seen in Zodiac EB, fig 15.61 (EB). This symbol also appears to convey the idea of day and night being symmetrical, or equal.

6) Crossed-out dais with a figure (of either a bird or a human in known zodiacs) upon it. This symbol could stand for either equinox, qv in fig. 15.61 (EM).

It also needs to be pointed out that if the dais isn't crossed out, the symbol in question is one of solstice and not equinox. In this case, the dais usually supports a cobra with its head raised, qv below. The crossing-out must have also expressed the idea of symmetry.

7) A figure with four heads, which can also stand for either equinox (see below). In Brugsch's zodiac the equinox and solstice symbols are located in corners, and the autumn equinox symbol is on the side of autumnal constellations. It looks like a winged animal with an equine body and four ovine heads, two facing either way (see fig. 15.61 – BR). In the inner zodiac of Petosiris the autumn equinox symbol is right next to Virgo; it looks like a male figure with four heads as described above, qv in fig. 15.61 (P2).

8.2. Symbols of the winter solstice point in Sagittarius. The "astronomical hieroglyph" of Sagittarius with a minimal horoscope

Symbols that stand for the winter solstice point in the constellation of Sagittarius can be seen in fig. 15.62. Let us list them.

1) In nearly every single Egyptian zodiac the winter solstice point with a minimal horoscope (Sun, Mercury and Venus) is part of the Sagittarian symbol, since the point in question is located in Sagittarius (fig. 15.62). Therefore, the Egyptian portrayal of Sagittarius was a complex compound symbol, uniting the actual figure of Sagittarius (as a centaur wielding a bow) and the symbols of the Sun, Mercury and Venus – planets that were in Sagittarius on the day of winter solstice. Let us cite a drawing that will make it clearer how Egyptian artists managed to combine all these assorted pieces of information into a single symbol, or, rather, an "astronomical hieroglyph" (see fig. 15.63).

It has to be said that the Sun, Venus and Mercury comprise a "minimal" (or "trivial") secondary horoscope. Indeed, the Sun is part of any secondary horoscope by definition. But the same is true about Venus and Mercury, since they never travel too far away from the Sun. As for other planets – their presence in secondary horoscope is a matter of chance. Therefore, the minimal secondary horoscope consists of the Sun, Mercury and Venus.

Let us now diverge from the astronomical topic for a while. Pay attention to the fact that Sagittarius was often depicted holding a composite bow, which is obvious by its characteristic reverse curve (fig. 15.63). The figure of Sagittarius is holding one of these (see zodiacs DR, EB and EM, for instance). However, it is known to us from the history of armaments that composite bows with a reverse curve have only been introduced in the XI century A.D. ([1181]). They were considered an expensive weapon even towards the end of the Middle Ages, since their manufacture was an extremely complex task in the days of yore. It suffices to say that such bows have only been used by sportsmen since the middle of the XX century and the invention of special synthetic materials. Prior to that, simple bows were used in sports ([1118:1]). It has to be remarked that the shooting range of a composite bow with a reverse curve is only limited by the strength of an archer's hands and may exceed that of a crossbow. It is believed that Mongolian (or Russian, according to our reconstruction) troops were armed by such bows ([1118:1]), likewise the Turkish janissaries ([1118:1]). Russian bows were of this sort, which is evident from the shape of the surviving quavers as well as ancient artwork that depicts Russian warriors – illustrations to the famous "Notes on the Affairs of the Muscovites" by Sigismund Herberstein, for instance ([161]).

This makes us wonder about just how this elite mediaeval weapon ended up in the "extremely an-

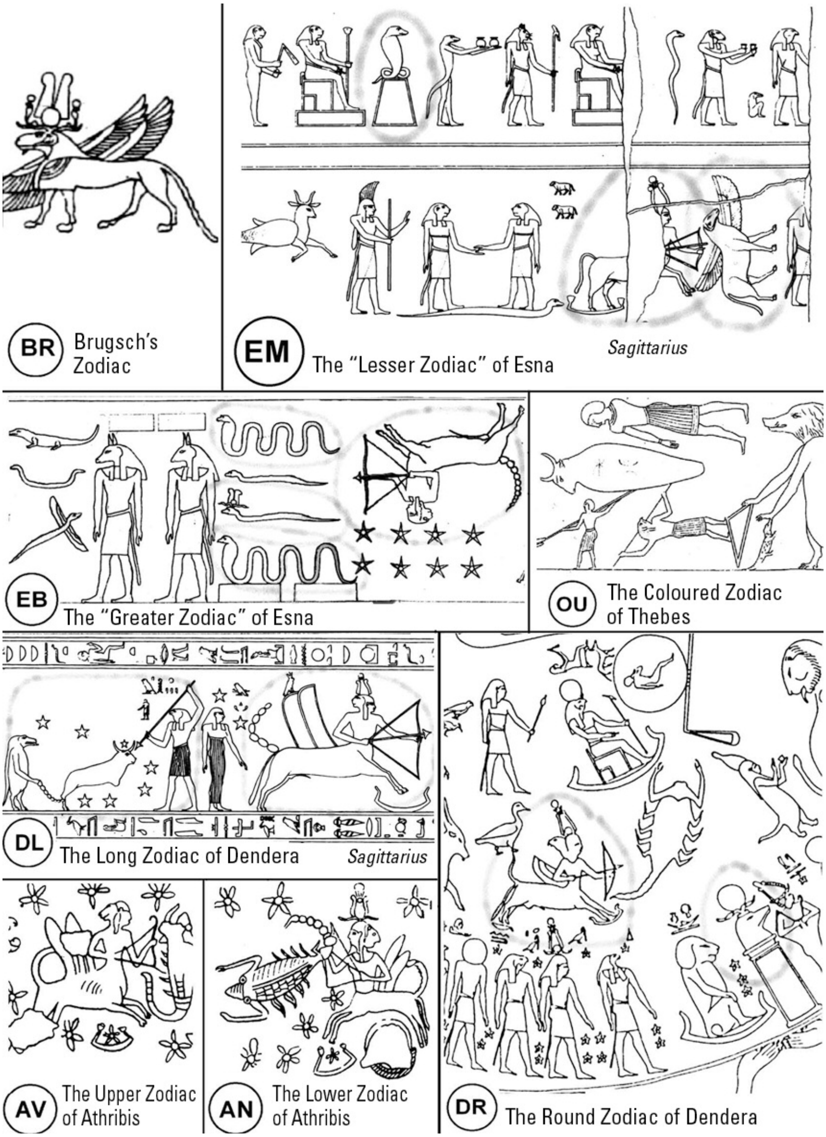


Fig. 15.62. Winter solstice symbols in various Egyptian zodiacs. Taken from [1100] and [544], Volume 6.

cient" Egyptian zodiacs. Incidentally, this is one of history's "mysteries" spawned by the erroneous chronology of Scaliger and Petavius. Namely, it is presumed that artful representations of composite bows with a reversed curve came into existence 30 centuries before our era, no less ([1118:1]). However, they have only been in use since the XI century A.D. What do we come up with as a result? An interval of four millennia, no less, between the invention of the bow and its introduction into military practice? This is impossible – the entire history of armaments tells us that new weapons are immediately tested in action.

How does one explain such bows drawn in Egyptian zodiacs, at any rate? The astronomical datings that we have come up with give us an exhaustive answer to this question. Apparently, all these zodiacs

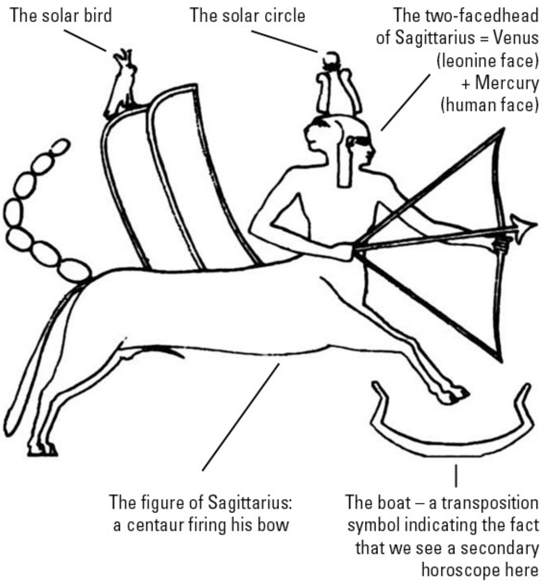


Fig. 15.63. The Egyptian "astronomical hieroglyph" that integrates the figure of Sagittarius as a centaur firing a bow together with the signs of the Sun, Mercury and Venus in Sagittarius on the day of the winter solstice using the Long Zodiac of Dendera as an example. The curious detail is the fact that Sagittarius is holding a composite bow, which is manifest in the characteristic bend this weapon has. These bows were used in the late Middle Ages, and were considered a rare and expensive piece of armament even then. One may well wonder about how a mediaeval weapon turned up in an allegedly "ancient" Egyptian zodiac. Our answer is that all these zodiacs were created in the Middle Ages or even later. The drawing is based on the drawn copy from [1100], A. Vol. IV, Pl. 20.

were created after the XI century A.D. – in the Middle Ages, that is. Therefore, there is little wonder that they depict mediaeval composite bows.

2) Cobra on a dais with its head raised and its neck stretched upwards, qv in fig. 15.62 (EM and EB). An identical or similar symbol could also indicate the summer solstice point. Other figures could be depicted here in lieu of the cobra – for instance, in the Round Zodiac of Dendera the dais in the point of winter solstice is occupied by the head of an animal with a circle between horizontal horns, qv in fig. 15.62 (DR).

It is significant that in this case the dais isn't crossed out and that the animal upon it hasn't got four heads. Otherwise it would be an equinox symbol, and not one of solstice.

It is possible that Egyptian artists adhered to a general idea of some sort by trying to emphasise horizontal symmetry in equinox symbolism, and vertical in case of solstice symbolism. This appears to be the case with Egyptian zodiacs in general, although there are exceptions. For instance, the sign of a symmetrical two-headed cobra was occasionally used to indicate the summer solstice point, qv below.

3) Fantasy animal that looks like a winged bull, qv in fig. 15.62 (EM and BR). It was usually depicted with an ovine head. The important detail is that there was just one head, not four – otherwise the symbol would represent an equinox and not a solstice. In the Lesser Zodiac of Esna (EM) such animals are located at solstice points and aligned vertically, perpendicular to the zodiac, qv in fig. 15.62 (EM). It may have been done in order to emphasise the vertical direction of the figures. A similar animal was used to indicate the point of summer solstice (see Zodiac EM, for instance).

4) The scene where the man with a falcon's head kills a calf with a spear (fig. 15.62 – DL and OU). In Brugsch's zodiac, this symbol is placed in between Cancer and Gemini, or at the point of summer solstice (see fig. 12.17). It is rather curious that in both cases the calf lacks front legs – usually just one hind leg is drawn with a rope tied thereto (fig. 15.62 – DL; also fig. 12.17). The whole meaning of the scene remains rather unclear. However, it is apparently related to solstice points in some way, since in every known case it is observed in the vicinity of these points.

8.3. Symbolism of the spring equinox point in Pisces

Symbols of the Egyptian zodiacs that stand for the point of spring equinox in Pisces are reproduced in fig. 15.64. They are as follows:

1) The tablet similar to the one found at the point of autumn equinox, as we have mentioned above. Such tablet can be found at the point of spring equinox in both Dendera zodiacs – the Long and the Round, qv in fig. 15.64.

2) Four-headed animal with two heads facing either side similar to the one depicted at the point of autumn equinox (see above). Such animal is present in the spring equinox point in the Round Zodiac of

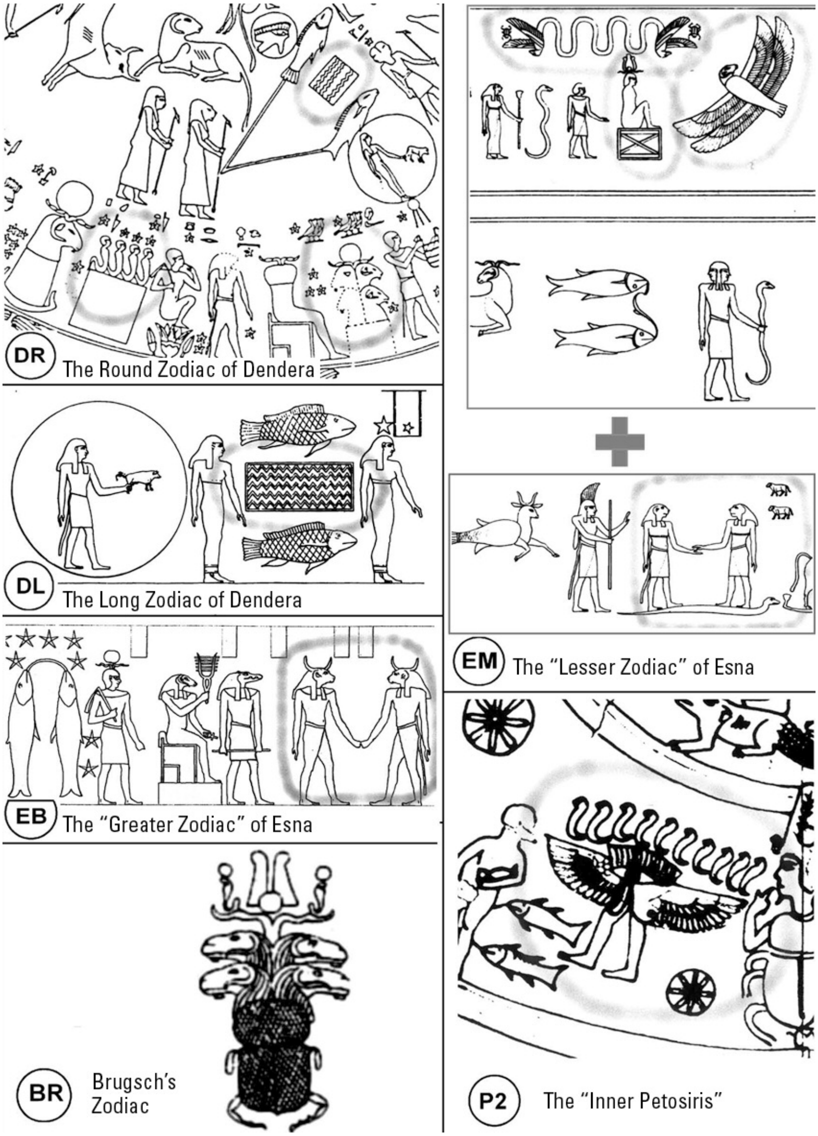


Fig. 15.64. Spring equinox symbols in various Egyptian zodiacs. Taken from [1100], [1062] and [544], Volume 6.

Dendera and Brugsch's Zodiac, qv in fig. 15.64 (DR and BR). It has the body of a beetle in Brugsch's zodiac, and all the heads are ovine, qv in fig. 15.64 (BR).

3) The row of several small snakes (cobras) with their heads raised, all facing the same direction. In the Round Zodiac of Dendera these snakes are placed on a dais, qv in fig. 15.64 (DR). In the P2 Zodiac from the inner chamber of Petosiris this row of snakes is topped by a most exotic symbol that looks like a winged eye with human legs, qv in fig. 15.64 (P2).

4) Symmetrical snake with two heads and wings on either side. There are identical little beetles in between the wings, qv in fig. 15.64 (EM). This symbol has already been discussed – it was also used for the autumn equinox point.

5) Figure on a crossed-out dais, qv in fig. 15.64

(EM). An identical symbol was used for the other (autumn) equinox point, qv above. The same zodiac could contain two different equinox figures on identical crossed-out daises (qv in the EM zodiac).

8.4. Symbols of the summer solstice point in Gemini. The "astronomical hieroglyph" of Gemini with a minimal horoscope

Symbols that indicate the point of summer solstice in Egyptian zodiacs are represented in figs. 15.65 and 15.66. Let us list them.

1) The actual figure of Gemini in Egyptian zodiacs is usually a composite symbol that unites the figure of Gemini with the Sun, Venus and Mercury. Therefore, the figure of Gemini, likewise the figure of Sagittarius as described above, can be regarded as a complex "astronomical hieroglyph".

The meaning of the astronomical hieroglyph of Gemini with the minimal horoscope being one of its parts is explained in fig. 15.67. The reference to Venus is the female gender of one of the Gemini figures (usually with a leonine face). Let us remind the reader that the latter is a symbol of Venus in the Egyptian zodiacs, qv in CHRON3, Chapter 15:4.8. Mercury is symbolised by the other Gemini figure, which is male and has a feather on its head – a symbol of Mercury. As for the feather being another symbol of Mercury, the reader can refer to CHRON3, Chapter 15:4.9, and CHRON3, Chapter 15:4.10. The Sun looks like a large circle over the head of the Venus figure of Gemini (see figs. 15.55 and 15.5).

It has to be said that the minimal horoscope per se cannot be of any assistance in the filtering-out of extraneous solutions, since it doesn't contain any non-trivial astronomical information. Nevertheless, the exact understanding of the meaning of such complex symbols is vital for the dating of Egyptian zodiacs. We shall witness this below, when we encounter a totally unexpected use of the "Gemini and Solstice" symbol. We shall see that a correct decipherment and dating of the entire zodiac is impossible without a clear understanding of the symbol's meaning. See our analysis of the EM zodiac in CHRON3, Chapter 18.

2) Male figure with a raised arm, qv in fig. 15.65 (DL, EM and AN; see also fig. 15.66). This figure is often (but not always) depicted standing in a boat. It may have a planetary rod it its other hand, being a symbol of the Sun (which was considered a planet in ancient astronomy). The raised arm is a very explicit symbol of summer solstice, which was mentioned several times above. This sign isn't used to symbolise winter solstice.

Let us point out that this summer solstice symbol is usually interpreted by the Egyptologists as a sign of the Orion constellation, which isn't part of the Zodiac. This serves as the basis for involved theories about the "intrinsic meaning" of the Egyptian astronomical texts. A fine example is the book of R. Bauval and E. Gilbert entitled "Secrets of the Pyramids. The Orion Constellation and the Pharaohs of Egypt" ([114:1]). We shall refrain from disputing the fact that theories similar to the one put forth by the above authors may contain rational elements. However, it can a priori be said that any detail of such theories based on the interpretation of said symbol of summer solstice as that of the Orion constellation is definitely erroneous. As our research demonstrates, it is most likely that neither Orion, nor any other non-Zodiacal constellation, was ever depicted in the Egyptian zodiacs.

3) Solar bird sitting on a tall pole (see fig. 15.65 – DR and DL). Also a very explicit symbol used for the summer solstice point exclusively.

4) A variation of the above sign. A straight pole in the middle with a broken pole on either side, the two of the latter bent and facing opposite directions. The symbol obviously expresses the concept of local maximum (straight pole) with symbols of wavering height on either side (bent poles). It was used in Egyptian zodiacs for referring to the summer solstice point, which is indeed the point of the Sun's maximal elevation above the horizon. The middle pole could be complemented by the symbol of a snake coiled around it (see fig. 15.65 – EB and EM; also fig. 15.66).

5) A fantasy animal: a winged bull (or calf) with an ovine head, which has already been mentioned in the context of winter solstice symbolism. An identical sign was used in Egyptian zodiacs for referring to the summer solstice point, qv in fig. 15.62 (EM; also fig. 15.66). If the animal has four heads instead of one, the symbol in question shall refer to an equinox and not a solstice.

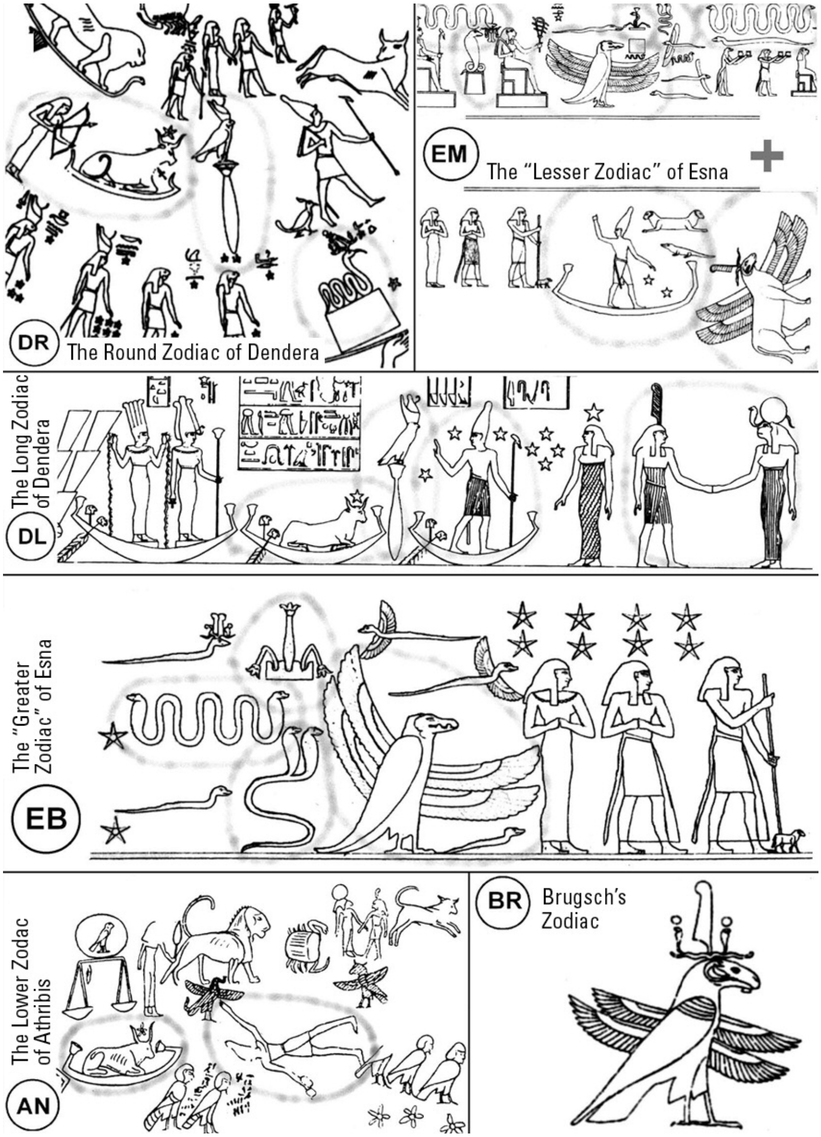


Fig. 15.65. Summer solstice symbols in various Egyptian zodiacs. Taken from [1100] and [544], Volume 6.

6) Fantasy bird with the head of a crocodile (or a ram). Apart from the usual wings, folded, the bird has another pair of spread wings similar to those of the bull with a ram's head mentioned in the previous section. We have only encountered this symbol in the point of summer solstice, which is the case with both zodiacs from Esna, where this bird has a crocodile's head (fig. 15.62 – EM and EB; also fig. 15.66). In Brugsch's zodiac it has the head of a ram, as well as a feather and two little cobras with solar discs on their heads, qv in fig. 15.62 (BR).

7) A symmetrical snake with a head on either side of its body, qv in fig. 15.65 (EM and EB; also fig. 15.66).

8) A cobra with two heads on a forked neck. Its whole body is stretched upwards, with both heads raised, qv in fig. 15.65 (EM and EB; also fig. 15.66).

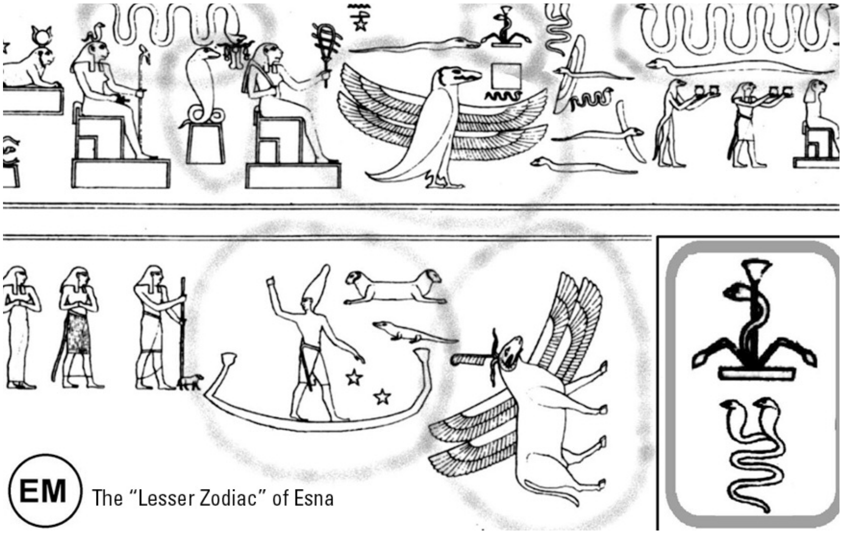


Fig. 15.66. Summer solstice symbols in the "Lesser Zodiac" of Esna (EM). On the bottom right we see a close-in of the two summer solstice symbols from the top part of the drawing. Previous illustration continued.

In order to conclude the present section, let us reproduce a drawn copy of the framing stripe of the Athribis zodiacs AV and AN (fig. 15.68). The entire row of symbols consists of the solstice and equinox symbols primarily (as described above). For example, the row of snakes all facing the same direction stands for the spring equinox. The two braided snakes in the lower right corner correspond to the autumn equinox (or, possibly, the vernal equinox once again). The cobra on a dais with its neck stretched upwards (qv in the lower left corner of the drawing) is a solstice symbol, as we already know.

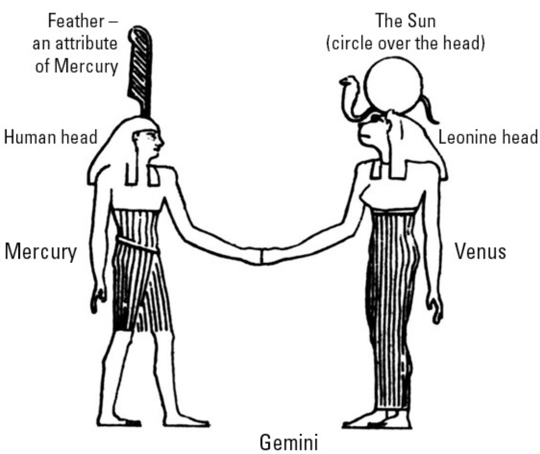


Fig. 15.67. An "astronomical hieroglyph" – the constellation of Gemini with a minimal horoscope (the Sun, Mercury and Venus) in the summer solstice point. Based on the drawn copy of the DL zodiac from [1100], A. Vol. IV, Pl. 20.

The entire lower part of the framing stripe is dedicated to the summer solstice. It also contains the secondary horoscope that was already discussed in Chron3, Chapter 15:5.3. Underneath, at the very bottom, we see a separate symbolic scene, which is of the greatest interest to us. We shall discuss it in the following section.

9. AUXILIARY ASTRONOMICAL SYMBOLS IN EGYPTIAN ZODIACS

Apart from the figures of the primary and secondary horoscopes, as well as equinox, solstice and constellation symbols, Egyptian zodiacs may contain certain auxiliary symbols (or even symbolic scenes) that have special astronomical meaning. Let us list a few of them presently – namely, the ones whose astronomical meaning is the clearest. It has to be noted that the number of auxiliary symbols as encountered

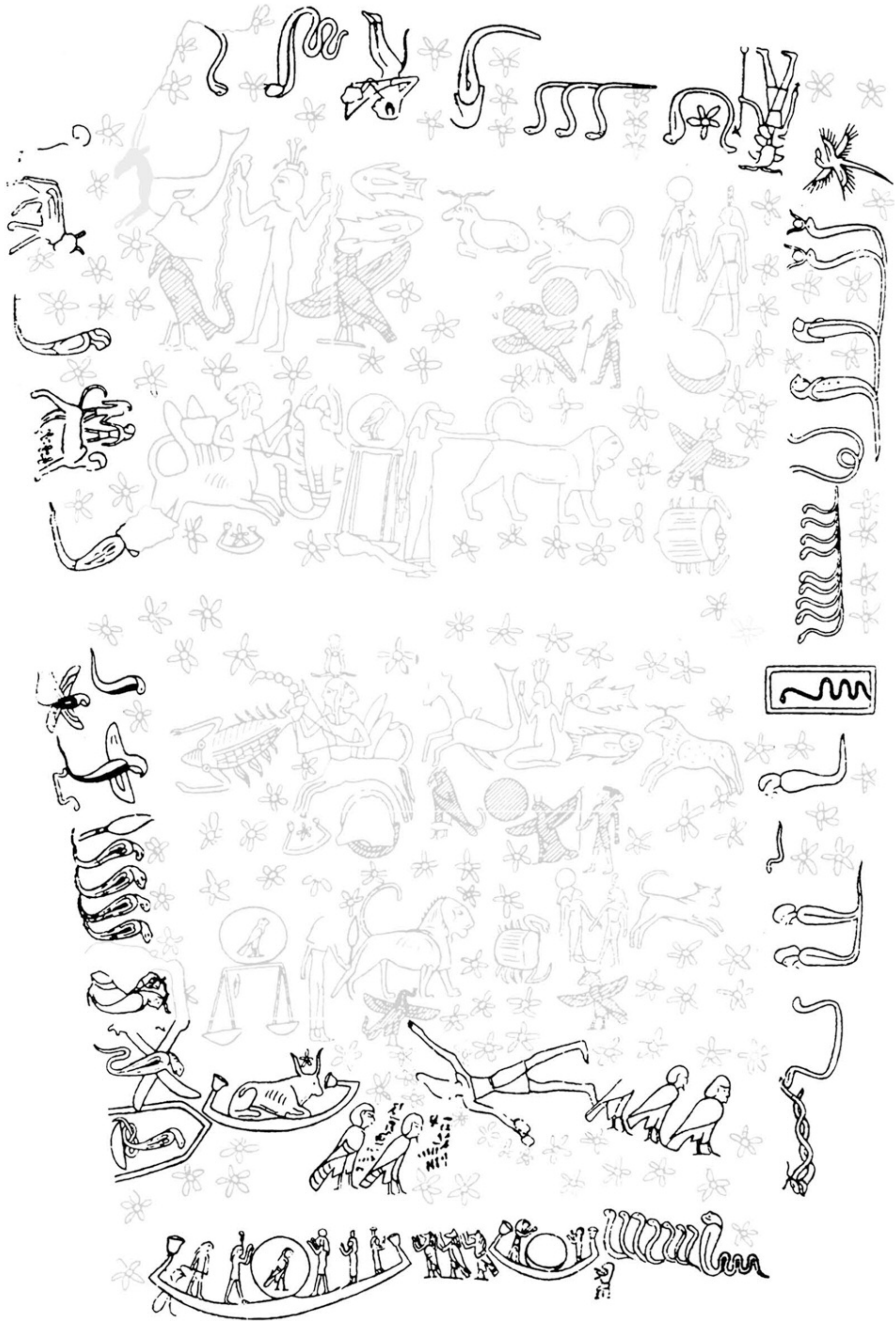


Fig. 15.68. The perimeter strip from the Athribis zodiacs (AV and AN). It consists of equinox and solstice symbols primarily – a row of snakes facing the same direction stands for the spring equinox; the two braided snakes – for the autumn equinox (or, possibly, the vernal one once again); the cobra on a dais with its head raised represents the solstice point. In the bottom part of the perimeter strip we see summer solstice with a secondary horoscope, and below that – the scene with the Passover moon born and growing. Based on the drawn copy from [544], Volume 6, page 730.

in Egyptian zodiacs is rather small as compared to the symbols of constellation and planets as well as solstices and equinoxes, which we have considered above. We have failed to decipher the meanings of certain auxiliary symbols. However, this appears to be of little importance inasmuch as the astronomical dating of the zodiacs is concerned. Most probably, the auxiliary figures and scenes don't contain any new dating information. However, their presence once again proves the important fact that each Egyptian zodiac is designed not just as an astronomical description of a certain date, but also the whole year that contains said date. The date itself is transcribed as the primary horoscope of the zodiac, with the most astronomical detail. Shorter astronomical descriptions found in the same zodiac can stand for other days of the same year (for instance, the secondary horoscopes correspond to solstice and equinox days).

Certain Egyptian zodiacs contain more information than that, referring to some other astronomical events of the year they describe. For example, some Egyptian zodiacs describe the first vernal full moon with varying amount of detail. Let us remind the reader that the astronomical event in question is the basis for the calculation of the Easter date, which is why such symbolism of the Egyptian zodiacs is yet another proof of the fact that their authors were Christian, although likely to practise a different kind of Christianity from the one that we're accustomed to.

Let us provide a list of the auxiliary astronomical motifs that we have encountered in Egyptian zodiacs.

9.1. The Easter Full Moon

As we have just mentioned, some of the Egyptian zodiacs depict the first Easter Full Moon. Let us remind the reader of the astronomical event in question and its significance.

According to the ecclesiastical rules that set the Easter date, this festivity was linked to the first full moon that followed the vernal equinox. Christian tradition knows of a special book called the Paschalia, which contains detailed astronomical calendar tables used for calculating such full moon dates. The development of the underlying astronomical calendar theory, in particular, the so-called Methon Full Moon Cycle of 19 years, was one of the key problems of mediaeval astronomy. According to Scaligerian chronology, this problem was solved in the III-IV century A.D., and the resulting solution was recorded at the First Ecumenical Council of Nicaea as Easter Tables, which are used by the Orthodox Church to this day. In the West these tables were changed for another kind in 1582, during the famous Gregorian reform of the church calendar. Our research demonstrates that in reality the Orthodox Easter tables were compiled a few centuries later than the Scaligerian version of history claims – in the VIII century A.D. the earliest. This is directly implied by the astronomical content of the tables, qv in CHRON6, Chapter 19.

The astronomical focal point of the Easter tables is the first Easter full moon. It is believed to have been a crucial element of ecclesiastical tradition even before the Christian Paschalia was introduced. It was also used for calculations of the Easter date by the ancient Judeo-Christian Church, as well as the Judean tradition, qv in CHRON6, Chapter 19.

At any rate, the first vernal full moon was an important element of the ecclesiastical tradition completely unrelated to the ancient Egyptian beliefs, as the Scaligerian version of history tries to convince us. Therefore, if we are to believe this version, we should by no means encounter obvious vestiges of the "alien" Christian tradition in Egyptian zodiacs. In particular, there should be no artwork associated with the first vernal full moon rites. Nevertheless, such artwork does exist, and it is very explicit to boot. This once again proves our theory that the "ancient" (or, rather, mediaeval) Egypt was a Christian country, qv in CHRON5. The matter is that Christianity was still very different from its modern variety in the XII-XIV century A.D. The Egyptians preserved this tradition up until the XVI century or even later.

A good example is the symbol found at the bottom of the Athribis Zodiacs of Flinders Petrie (zodiacs AN and AV). We reproduce it in fig. 15.69. It is a symbolic scene whose meaning is perfectly clear, given everything we already know about the symbolism of the Egyptian zodiacs. The scene is to be "read" from right to left, which is the direction almost all of its figures are facing.

At the beginning (the first symbol of the procession from the right) we see the already familiar vernal equinox symbol that looks as a row of snakes, all

Fig. 15.69. The Athribis zodiacs (AV + AN). The symbolic scene with the Passover moon born and growing after the vernal equinox. From right to left: 1) spring equinox symbol that looks like a row of snakes all facing the same direction; 2) narrow crescent in a small boat – the birth of the Passover moon after the spring equinox; 3) full moon reflecting the solar bird in a large boat – the Passover full moon. Fragment of a drawn copy from [544], Volume 6, page 730.

facing the same direction. This is a reference to the day of vernal equinox, qv in fig. 15.69.

Next we have a small boat holding a circle that comprises a narrow crescent. It is guarded by two human figures located on either side. We see the birth of the new moon after the day of the vernal equinox, or the birth of the moon that shall become the Easter Full Moon 15 days later (see fig. 15.69). Bear in mind that the boats are used in Egyptian zodiacs as transposition symbols, telling us that the scenes they depict bear no relation to the date of the primary horoscope (transposition in time), and, occasionally, that they're also unrelated to the constellations where they are located in the zodiac (transposition in space).

Finally, the whole scene is concluded by a much larger boat that carries the Full Moon (with no crescent inside this time; the circle contains a bird instead). As we have already mentioned, the bird is an Egyptian symbol of the Sun. The entire Egyptian symbol in question is a reference to the Full Moon, which is perfectly correct astronomically. In other words, the Moon was reflecting the sunlight with the entire surface of the side visible to the Earth observer as a full circle. In other words, we see the first full moon after the vernal equinox, or the Easter Full Moon (see fig. 15.69).

The same Easter Full Moon is also reflected in both Athribis Zodiacs as an identical circle with a bird inside, both times in Libra, qv in fig. 13.9 above. Is this a random occurrence? Why did the Easter Full Moon end up in Libra both times?

There is nothing random about this fact. It is easy enough to realise that the Easter Full Moon always takes place in Libra or the immediate vicinity of this constellation. Indeed, let us consider the position of the Sun on the day of the Easter Full Moon. It can be calculated very easily. On the day of the Spring Equinox the Sun was in Pisces. We have seen this fact reflected in every Egyptian zodiac quite unambiguously. Furthermore, the Easter Full Moon takes place 15 days later than the corresponding astronomical New Moon, which takes place after the day of the vernal equinox in half of the cases. Alternatively, it can be said to occur 14 days after the crescent of the New Moon appears in the sky, since this only happens on the day that follows the precise astronomical New Moon date. Therefore, if the equinox falls in between the Full Moon and the New Moon, the distance between the equinox and the first New Moon that follows it shall equal 1 to 15 days. The Easter Full Moon can only occur 15 days later. Thus, in half of the cases the Easter Full Moon takes place about 15 days after

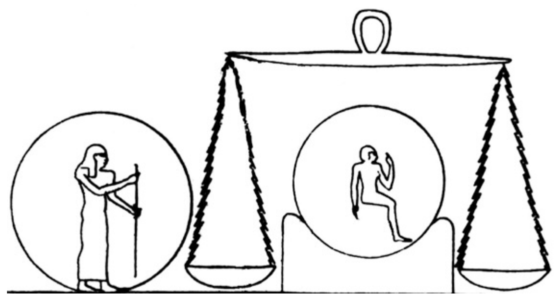


Fig. 15.70. The Passover Full Moon in Libra and the primary horoscope full moon in the Long Zodiac of Dendera. The Passover full moon is drawn as a circle integrated into the sign of Libra, as usual. The Moon in the primary horoscope is drawn nearby as a circle with a woman holding a stick, or a rod, in the middle. Fragment of a drawn copy from [1100], A. Vol. IV, Pl. 20.

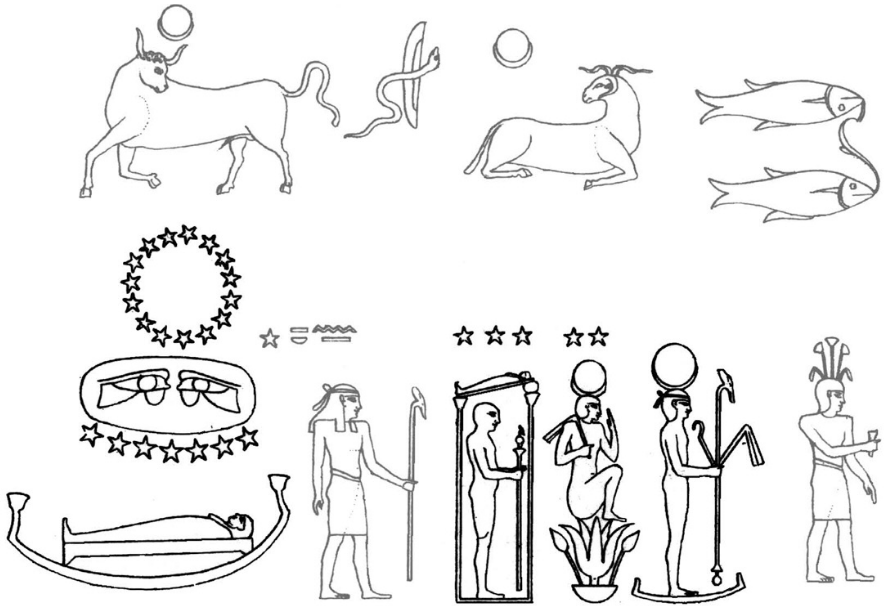


Fig. 15.71. The Passover Full Moon and the Easter celebrations as reflected in the "Lesser Zodiac" of Esna (EM). We see a fragment that depicts the constellations of Pisces, Aries and Taurus. Underneath Pisces and Aries one sees two figures with lunar symbols over their heads. They have transposition signs under their feet – in other words, they bear no relation to the primary horoscope. One of these figures looks like an infant sucking on its hand; it stands for the new Moon. The two stars over its head might be a reference to its two days of age. The second figure is standing straight and holding a planetary rod. It is the full Moon. The scene is interrupted by a primary horoscope planet, and continued underneath the constellation of Taurus. We see a boat here, which serves as a transposition symbol. The scene above apparently refers to some seven-day feast of resurrection, which is related to the 15-day (full) vernal Moon. The celebration in question must be the Christian Easter, which corresponds to the drawing ideally. Fragment of a drawn copy from [1100], A. Vol. I., Pl. 87.

the equinox, and in the rest of the case this term approximates 30 days. The Sun shifts its position on the Zodiac by some 15-30 degrees over this time, and ends up in the constellation of Aries. If the vernal full moon comes particularly late, the Sun may pass the whole constellation of Aries over the course of this time (which occupies a mere 20 degrees of the ecliptic) and wind up in Taurus. On the contrary, if the vernal full moon came very early, the Sun shall be at the cusp of Pisces and Aries.

At any rate, the Sun must be in Aries or right next to this constellation on the day of the first vernal full moon.

Let us now recollect that when the Moon is full, it opposes the Sun as seen from the Earth. In other words, when we face the full moon, we shall have the Sun right behind us, otherwise we shall fail to see the entire sunlit half of the Moon, which cannot be full by definition in this case. Therefore, the Moon is on the opposite side of the Zodiac from the Sun on the day of the Full Moon. So, if the Sun is in Aries, the Moon shall be right across the zodiac – in Libra. The Easter Full Moon can therefore be found in Libra or close nearby.

This explains why the circle in Libra can be found in the majority of Egyptian zodiacs. This is the very Eater full moon. In certain cases, the circle could also stand for the Moon in the primary horoscope, but only when the horoscope Moon coincided with the Easter Full Moon. We shall encounter this in case of the Round Zodiac of Dendera. As for the Long Zodiac of Dendera, the primary horoscope moon was full as well, but fell on a different month than the Easter Full Moon, which is why there are two circles in Libra: one stands for the horoscope moon, and the other – for the Easter Full Moon, qv in fig. 15.70.

We must add that in most cases the circle in Libra, which is constantly found in Egyptian zodiacs, simply cannot be related to the primary horoscope in most cases – it would be an astronomical impossibility. Neither the Sun, nor the Moon of the primary horoscope could wind up in Libra randomly quite as often. Moreover, in many Egyptian zodiacs, the ones from Athribis being no exception, the Sun and the Moon of the primary horoscope are explicitly indicated in other places – not in Libra. Nevertheless, they still have a circle in Libra. Therefore, in most cases the circle in Libra is unrelated to the primary horoscope, most likely referring to the Easter Full Moon.

The abnormally frequent incidence of circles in Libra in Egyptian zodiacs was already pointed out by N. A. Morozov. This is what he writes about the circle in Libra in Brugsch's zodiac, for example: "This very symbol of Libra with a solar circle at the beam is very common for the ancient astronomical zodiacs" ([544], Volume 6, page 697). N. A. Morozov is correct to point out the exceptionally frequent circle in Libra; however, he makes a mistake in his unjustified assumption that the circle in Libra is a solar symbol. Quite possibly, N. A. Morozov wasn't entirely sure of this, since he claims this circle to be a symbol of the Justice Goddess elsewhere (in his analysis of the Dendera zodiacs, qv in [544], Volume 6, page 658), also without providing any explanations.

The implication is that N. A. Morozov wasn't capable of deciphering the full meaning of the Egyptian astronomical symbol in question. His corollary was that the circle in Libra "cannot be a horoscope indication" ([544], Volume 6, page 697). However, this isn't true in some cases. As we have discovered in the course of our analysis of Egyptian zodiacs, in some cases the circle in Libra is directly related to the primary horoscope – this happens when the horoscope Moon on the zodiac coincides with the Easter Full Moon, a good example being the Round Zodiac of Dendera, qv below.

We can apparently see a similar representation of the Easter Full Moon in the Lesser Zodiac of Esna (EM). In fig. 15.71 we see a fragment of the zodiac in question that contains the constellations of Pisces, Aries and Taurus. Underneath Pisces and Aries we see two figures with circles on their heads. Each of these circles contains a crescent, which is a lunar symbol. Both figures stand on transposition symbols (a flower and a boat, respectively). Therefore, neither is part of the primary horoscope.

One of the figures is already familiar to us – an infant sucking on a thumb. This was a lunar symbol in Egyptian zodiacs, qv above. It has two stars over its head – apparently a symbol of the Moon being two days of age. The matter is that the narrow crescent of the New Moon can only be seen two days after the Moon goes out of sight. Therefore, from the point of view of the ancient astronomers, the new moon was already two days of age when it appeared in the sky.

The position of the second figure with an identical crescent over its head is different – it is standing tall and holding a sceptre, a whip and a planetary rod. This is also a symbol of the Moon – this time "grown up" and full. Also, the transposition symbol (the boat that supports the second figure) is temporal as well as spatial, given that the "proper" place of this Moon is on the opposite side of the Zodiac.

It has to be said that the full Moon is always found on the side of the Zodiac that opposes its "birthplace". The "nascence" of the Moon always takes place in the vicinity of the Sun, and it becomes full on the other side of the Zodiac. However, the Sun doesn't manage to get all that far way over the 15 days that it takes the Moon to become full – it only travels the distance of half a constellation on the Zodiac. Therefore, the Full Moon appears in the vicinity of the constellation opposite to the one where it was "born".

Nevertheless, the two transposition symbols make it feasible for both moons (the "young" and the "old") to be depicted side by side, which is the case with the Lesser Zodiac of Esna, without compromising the astronomical veracity. These symbols were widely used by the "ancient" Egyptian makers of the zodiacs.

However, there are quite a few more references to the Easter Full Moon in the Lesser Zodiac of Esna. The most interesting part comes later, underneath the constellation of Taurus, after the interruption of the whole scene by a solitary planetary figure – male, without any transposition symbols under it, qv in fig. 15.71. This must be one of the primary horoscope's planets. It is followed by a large boat, once again a transposition symbol. Over the boat we see a most remarkable scene, which is difficult to interpret in any other way but as a symbolic representation of the seven-day festivity

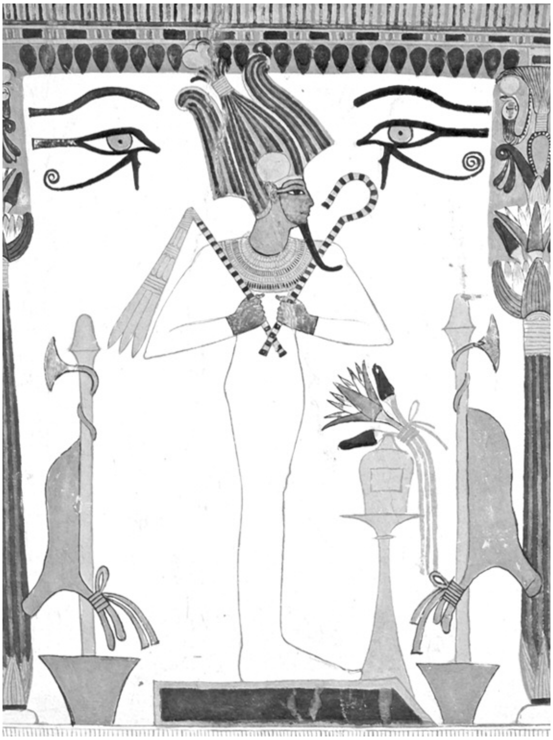


Fig. 15.72. Ancient Egyptian drawing of Osiris rising from the dead. We see him stand up from the coffin inside an anthropomorphic sarcophagus. The fact that we're seeing a sarcophagus is emphasised by the gigantic size of its only foot, which is exactly how the Egyptian anthropomorphic sarcophagi were made. Under the feet of the risen Osiris we see his grave with flowers on the gravestone. His symbol (the "Egyptian eye") is drawn on both sides of his head. We also see two poles to his sides, with two decapitated animals tied thereto. They might be symbolising the two robbers crucified next to Christ. A mural from the Valley of the Craftsmen ("the tomb of Sennedjem). Taken from [2], page 2.

celebrating the resurrection of Osiris, which starts when the Moon is full and 15 days of age. This fits the definition of the Christian Easter to the minor detail. Let us study this amazing artwork that depicts Christian Easter in the "ancient" Egyptian Zodiac EM. It consists of the following parts (see fig. 15.71):

1) Right above the boat we see a man in a coffin. He is dead, qv in fig. 15.71. It will shortly become clear that the figure in question represents the Egyptian Osiris, or Christ before resurrection.

2) Above the man in a coffin we see two Egyptian eyes circumscribed by an oval. Egyptologists believe these to be the "eyes of Ra" (or "eyes of Horus"), the Egyptian symbols of the Sun and the Moon, qv in [1051:1], page 54. Alternatively, they are called "the eyes of Osiris" ([1062], page 68; also [2], page 2). Such eyes can be seen drawn on either side of Osiris in the ancient Egyptian drawing reproduced in fig. 15.72, for instance.

It has to be emphasised that in Zodiac EM both Egyptian "eyes of Ra" are circumscribed by an oval and not a circle. Therefore, the symbol in question is unlikely to represent either the Sun or the Moon (there would be a circle instead otherwise). Most probably, the symbol represents the resurrecting Osiris (or Christ). Let us recollect that, according to the "ancient" Egyptian tradition, Osiris had been killed and later rose from the dead ([532], page 419).

Underneath the oval we see seven stars. This can also be regarded as a direct reference to the fact that the Easter celebrates the resurrection of Christ on the seventh day.

3) Finally, the entire scene is topped by a symbol consisting of 15 stars arranged in a circle. This is a very obvious symbol of the Full Easter Moon, 15 days of age as counted from the day of vernal equinox. It is indeed closely associated with the Easter.

Thus, what we see in one of the "most ancient" Egyptian zodiacs is an explicit representation of the seven-day festivity commemorating the resurrection of Christ, which is connected to the 15-day Full Moon shortly following the spring equinox. We see a very detailed description of the Christian Easter!

All of the above is in excellent correspondence with the date transcribed in this zodiac, as revealed by astronomical calculations. This date is the 6-8 May 1404, and pertains to the XV century A.D., or a late mediaeval period. See more on the dating of the EM Zodiac below. Consequently, the actual Lesser Zodiac of Esna was compiled even later.

9.2. The solar bird in the Long Zodiac of Dendera (DL)

The Long Zodiac of Dendera has six symbols of an identical bird, which is drawn as though it were moving from one place to another over the course of the whole year represented by the zodiac. It is the

Sun on its annual journey across the Zodiac. The "stops" made by the solar bird in the Long Zodiac (or the places where we encounter this symbol) are as follows:

1) The second ten-degree segment of Virgo. Here it indicates the place of the secondary horoscope of autumn equinox built into the ten-degree figure (see above). Simultaneously, we see the Sun crossing the autumn equinox point.

2) In between Scorpio and Sagittarius, following the "wolf on a scythe" symbol, whose meaning remains unclear to us (this symbol can be found in both Dendera Zodiacs; see more about it below). Here the solar bird is wearing a tall hat.

3) At the tip of the wing belonging to the winged equine part of Sagittarius. Here it marks the Sun crossing the winter solstice point.

4) Next to the first ten-degree segment of Capricorn, right after the slaughter scene of a calf with one leg. Here the bird has horns and also acts as part of the secondary winter solstice horoscope, "overlapping" with the adjacent constellation of Capricorn.

5) Over the heads of the little animals with their backs attached to each other – the symbol of dusk and dawn, which follows Venus in the primary horoscopes

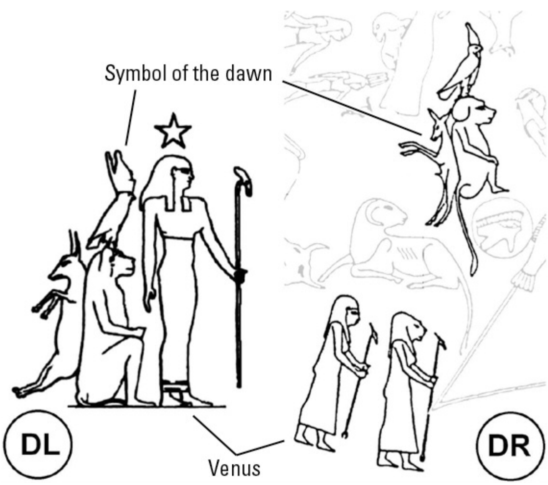


Fig. 15.73. Little animals with their backs grown together and a solar bird over their heads – a symbol of the dusk and the dawn. This symbol accompanies Venus in the Dendera zodiacs. On the left one sees a fragment of the Long Zodiac, and a fragment of the Round Zodiac on the right. Drawn copy fragments from [1100], A. Vol. IV, Pl. 20 & Pl. 21.

of both Dendera Zodiacs, qv above. The solar bird is part of the symbol.

6) On top of the pole at the very end of the zodiac, after Gemini. This is a symbol of summer solstice, qv above, and it depicts the Sun as it crosses the respective point.

One might wonder why the spring equinox point in the Long Zodiac of Dendera isn't marked by such a bird, given the paramount importance of this solar point in ancient astronomy. We shall explain this below, in the section about the dating of the Long Zodiac, and demonstrate that the spring equinox point on this zodiac is marked by a special symbol of unusually large size, proportional to its significance. The remaining three solstice and equinox points are marked with the solar bird symbol.

9.3. The symbol of dusk and dawn

The Egyptian symbol of dusk and dawn looks like two small animals with their backs attached to each other and a solar bird over their heads (see fig. 15.73). This symbol can be seen next to the figure of Venus in the primary horoscopes of both Dendera zodiacs. N. A. Morozov appears to be perfectly correct in his opinion that the symbol stands for the dusk and the dawn. This is what he writes about this symbol in the Long Zodiac: "the dusk and the dawn with two little animals with their backs attached to one another, with a falcon over their heads" ([544], Volume 6, page 677). It is easy enough to understand why it accompanies Venus in Egyptian zodiacs. Venus was considered a "double star" by the ancient astronomers, since it can be spotted twice – at dusk and at dawn.

9.4. The decapitation scene next to Aquarius

In both Dendera Zodiacs we see the "decapitation scene" next to the constellation of Aquarius. A man with a knife in his hand has grabbed some animal by the ears and demonstrates the intention to decapitate it. In the Long Zodiac the decapitated figure is human, qv in fig. 15.74. It is most likely that the scene depicts the decapitation of John the Baptist, symbolised by Aquarius. We have already discussed this issue at length above, in the section about the symbolism of Aquarius in Egyptian zodiacs.

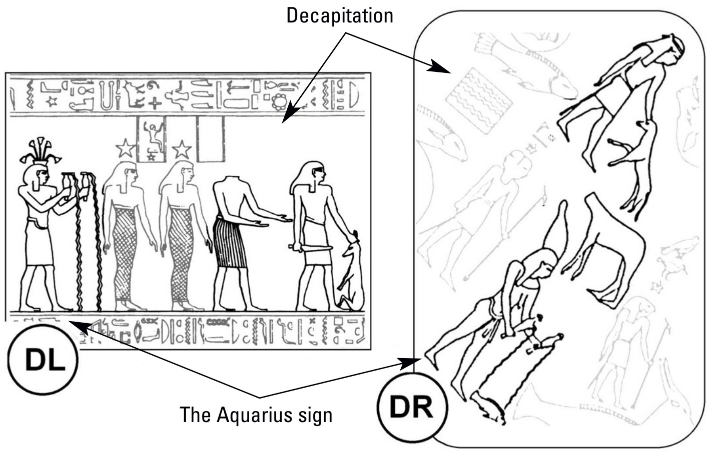


Fig. 15.74. Decapitation scene near Aquarius in the Dendera zodiacs. The man with a knife in his hand has grabbed some animal by the ears in preparation to decapitate the latter. Nearby we see a headless figure. In the Long Zodiac the headless figure is a human one. The Long Zodiac of Dendera is on the left, and the Round one is on the right. Drawn copy fragments from [1100], A. Vol. IV, Pl. 20 & Pl. 21.

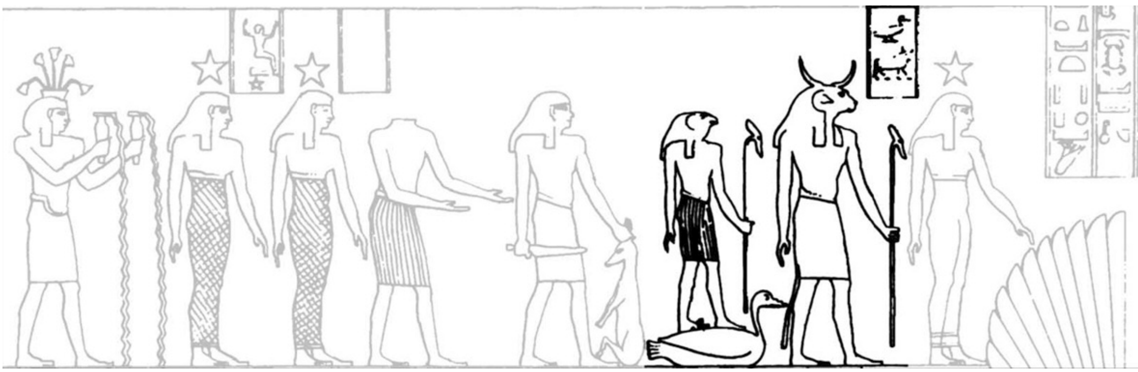


Fig. 15.75. Mars on a goose next to Saturn in the Long Zodiac of Dendera (DL). The goose under the feet of Mars serves as a transposition symbol, indicating the fact that the present position of Mars doesn't correspond to that in the primary horoscope. At the same time, the goose, which is an attribute of Mars in Egyptian zodiacs, emphasises that we are looking at Mars and not some other planet. The entire scene refers to the meeting of Mars and Saturn on the year transcribed in the present zodiac. We must point out that the figure of Saturn belongs to the primary horoscope. However, Saturn moves exceptionally slowly, and its primary horoscope position remains valid during the entire year. Fragment of a drawn copy from [1100], A. Vol. IV, Pl. 20.

9.5. The stabbed calf (bullfighting scene)

Let us consider fig. 15.76. Above we have already mentioned the scene where the man with a falcon's head is stabbing a calf, which has only got one leg, to death with a spear (in the context of winter solstice symbolism). We have voiced the assumption that the scene in question was somehow associated with solstice points. However, we are not completely sure of this, since the available data aren't sufficient for any finite conclusion. Furthermore, the exact meaning of the scene and the exact nature of its relation to the solstice points remain unclear.

It is therefore possible that the scene in question is not purely astronomical, and that the symbol is closer to religion and astrology, similarly to the decapitation scene as described above. In other words, it is possible that some scene from the Holy Writ has been represented in astral (or celestial) symbols. It is hard to decipher their exact meaning – we can simply point out that the feast of stabbing a calf (or a bull) to death was already well known in the Middle Ages, and hails from a Christian country – Spain, where it exists to this very day (the famous bullfighting). It is possible that the Spanish bullfighting is another memory of the same event as depicted in the Egyptian zo-

diacs as the scene with the one-legged calf stabbed to death. The event in question might be in some relation to Jesus Christ, since the ancient artwork that depicts "the god Mithras" stabbing a bull to death is most likely to be referring to Christ in each case (see CHRON1). However, the Gospels haven't preserved the memory of this event.

9.6. Wolf on a scythe in the zodiacs of Dendera

Let us take a look at fig. 15.77. In both Dendera zodiacs we see the rather strange symbol of a wolf (or a dog) standing on a scythe. In the Long Zodiac it is located between Sagittarius and Scorpio. In the Round Zodiac we find it at the centre of the zodiacal circle, where the celestial pole should be. The meaning of the symbol is unclear.

9.7. The conjunction of Mars and Saturn in the Long Zodiac of Dendera

In the Long Zodiac of Dendera, on the right of the decapitation scene, we see Mars with a planetary rod in his hand riding a goose (see fig. 15.75). The nearby figure is Saturn in the primary horoscope, with a crescent on its head. The goose is a transposition symbol (see more about such symbols above), and indicates that the current position of Mars does not correspond to that of the primary horoscope. Simultaneously, the goose, which is a symbol of Mars in Egyptian zodiacs (qv above) emphasises that the planet in question is Mars and none other. The entire scene probably describes the conjunction of Mars and Saturn falling over the year transcribed in this zodiac. Unfortunately, the scene gives us no new dating information, since it is implied by the primary horoscope with a large degree of probability and doesn't add anything to it.

Nevertheless, what we see is a very obvious example of how astronomical events unrelated to the primary horoscope could be referred to in Egyptian zodiacs. In other cases, similar artwork might well prove useful for the decipherment of the zodiacal date.

We have to emphasise that the symbol of Saturn pertains to the primary horoscope. Due to the very slow motion of Saturn, its position doesn't change all that much over the course of a year, which is why

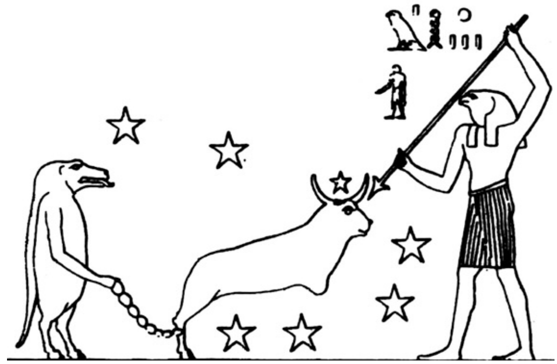


Fig. 15.76. The slaughter of a calf (bullfighting?). The man with a flacon's head is using his pike to slaughter a calf with a single hind leg. Fragment of the Long Zodiac (DL). The scene might be some kind of an astral/religious symbol, likewise the decapitation of John the Baptist in the constellation of Aquarius. It is hard to say what exactly is meant here – still, one must remember that the mediaeval bullfighting tradition is still very much alive in Christian Spain (the famous corrida). Drawn copy fragment from [1100], A. Vol. IV, Pl. 20.

its position in the primary horoscope remains constant. Therefore, Saturn's position in the zodiac can be indicated by a single figure that serves the primary horoscope and all the other astronomical aspects of a given year.

10. LEGITIMATE AND ILLEGITIMATE ZODIAC DECIPHERMENTS

We have calculated all possible (legitimate) decipherments of every zodiac's primary horoscope in our research. Versions considered legitimate included possible correspondences between zodiacal figures and real planets that accounted for the most reliable and unambiguous conjectures of the previous researchers of Egyptian zodiacs in re the astronomical meaning of certain symbols and figures. The greatest advances in this direction were made in the works of N. A. Morozov ([544], Volume 6). Vital new discoveries were related in the work of T. N. Fomenko ([912:3]).

We have been very careful with our choice of conditions, striving to reject all extraneous and even slightly dubious data. Unwarranted restrictions might

lead to the rejection of correct astronomical solutions, and, ultimately, failure to find the astronomical dating of a given zodiac. Fortunately, in our approach erroneous restrictions do not spawn erroneous solutions as a rule – there are no solutions. Due to the effect of secondary horoscopes, errors in the decipherment of a zodiac usually make it impossible to come up with so much as a single ideal astronomical solution.

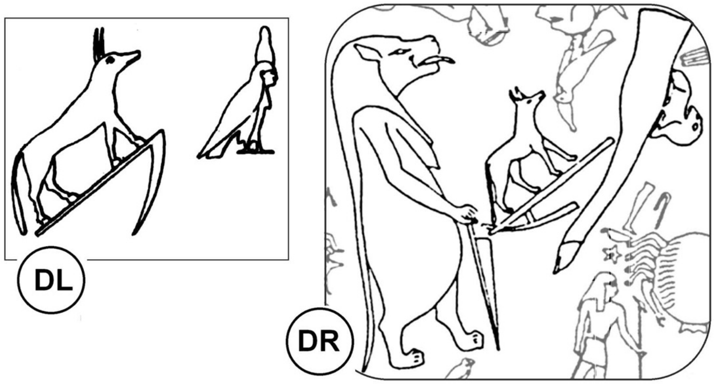


Fig. 15.77. Wolf (or dog) on a scythe. In the Long Zodiac we see this symbol between Sagittarius and Scorpio, and in the Round one it is in the centre of the zodiacal circle, where the celestial pole should be. The Long Zodiac of Dendera is on the left, and the Round one is on the right. Drawn copy fragments from [1100], A. Vol. IV, Pl. 20 & 21.

On the other hand, even if we did miss certain justified conditions, this is of no consequence here, since the set of conditions already used suffices for a solution, which is a single astronomical date in case of each particular zodiac. A propos, the very existence of such a solution (which is unique, as we feel obliged to remind) tells us that the conditions we used really contain no unwarranted elements.

We could keep on making the decipherment conditions less rigid, keeping their set to a minimum. However, this would give us more dubious or a priori erroneous versions, which, in turn, would expand the volume of astronomical calculations dramatically. Apart from that, we seldom encounter novel solutions, even in this case. We have performed some additional calculations that demonstrate it to be true. Arbitrary and random decipherments of Egyptian zodiacs give us no satisfactory solutions.

Obviously enough, a given decipherment version has to fit all Egyptian zodiacs uniformly. The decipherment of a single zodiac can be altered in order to give another satisfactory solution (which translates as another date). However, this is impossible to do for all Egyptian zodiacs at once.

Let us therefore list our zodiac decipherment conditions. We have formulated the reasons for each of them elsewhere, and will therefore withhold from reiterating them presently.

1) *First condition.* The astronomical meaning of any figure or symbol in the zodiac shouldn't contradict the meaning of similar figures or symbols in other Egyptian zodiacs. In other words, our research was based on the assumption that all ancient Egyptian zodiacs shared a single system of symbols. Therefore, if we encounter one symbol or another in several different zodiacs, we are safe to assume that it means the same thing in every case (or, at least, that such meanings do not contradict each other).

It goes without saying that we cannot claim this to be true for all Egyptian zodiacs without exception. However, should this fail to be the case, we wouldn't have been able to find ideal astronomical solutions for each and every zodiac, acting on this assumption. Indeed, the amount of astronomical information found in zodiacs can be great enough, as we have already seen. Therefore, the possibility that there might be random ideal astronomical solutions of all Egyptian zodiacs based on an erroneous decipherment is right out of the question.

However, since ideal solutions were indeed found for each and every zodiac, we can consider the principle of uniform approach to the decipherment of all Egyptian zodiacs justified.

2) *Second condition.* If we find an inscription of some sort next to a planetary figure in a zodiac, it must be accounted for in decipherment. In other words, the stipulation is that the astronomical decipherment of a zodiacal figure should not contradict the adjacent inscription. This was, obviously enough, only taken into account in cases where translations of such inscriptions were available. One must admit that

said translations are more often than not ambiguous and vague, which makes it impossible to obtain any decisive astronomical indications from these inscriptions. Nevertheless, they are of some help in decipherment. Some such inscriptions were translated by H. Brugsch, a famous Egyptologist of the XIX century, who studied the issues of deciphering the astronomical content of Egyptian zodiacs, among other things. N. A. Morozov referred to his translations liberally ([544], Volume 6). We have also been using Brugsch's translations for reference in our research.

3) *Third condition.* Venus, being a female planet, has to be symbolised by a female figure, not male. N. A. Morozov was the first to point this out, correcting the mistake of Heinrich Brugsch, who identified a male planetary figure from the Round Zodiac as Venus, qv above.

In some of the zodiacs a single planet is symbolised by a whole procession of wayfarers and not just a single figure (Zodiac EM, for instance). In this case, the procession of Venus must contain a single female figure at the very least.

Vice versa, neither Saturn, Jupiter or Mercury were ever depicted as female figures – those planets were believed to be "strictly male" in their symbolism.

The Sun was also considered a male planet in European and Egyptian astral symbolism ([532], page 145; also [370], pages 14-15). However, in case of the Sun we have made no ban on female figures in zodiac decipherment. This is of little importance, at any rate, since the Sun in the primary horoscope was usually drawn as a circle and not a human figure, thus rendering the gender issue irrelevant. However, the Sun is often drawn as a human figure in secondary horoscopes of Egyptian zodiacs. Our research has revealed that the figures in question are always male (see the secondary horoscopes in Zodiac DR, for example).

As for Mars – the figure itself is male, according to mythology, but may be accompanied by female figures. In Roman mythology, for instance, Mars was often accompanied by the female image of "Mars's Valour": "The wife of Mars was Nerio, or Neriene, identified as Venus and Minerva, initially the 'Valour of Mars'" ([532], page 349). In Greek mythology, where Mars was known as Ares, "his companions were Eris, the Goddess of Discord, and the blood-thirsty Enio" ([532], page 58). In other words, Mars had female companions; it is possible that some of them ended up in the zodiacs as well. Also, Greek mythology employs the female figure of Athena as a "double" of Mars, in a certain sense.

Therefore, we considered couples and processions consisting of figures of either gender acceptable for Mars, and even solitary female planetary figures, as long as this didn't interfere with the identification of Venus. However, our study of finite solutions revealed that Mars was always portrayed as a male figure in Egyptian zodiacs.

By the way, we have already discussed how male and female figures can be told apart in Egyptian zodiacs. The easiest way is to take a look at the width of a given figure's step, which is always substantially smaller in case of female figures as drawn by the "ancient" Egyptian artists.

4) *Fourth condition.* A two-faced male figure holding a planetary rod stands for the planet Mercury in every Egyptian zodiac. See more in the section on the symbols of Mercury in the primary horoscope above. As for the error of Brugsch, who identified the two-faced figure in the Zodiacs of Dendera as Venus (see more on the primary horoscope's symbols of Venus above, in the corresponding section). Unfortunately, Brugsch's mistake has been recurring in the works of numerous Egyptologists to this day ([1062:1]).

The two-faced wayfarer doesn't necessarily appear in an Egyptian zodiac. Mercury could be portrayed differently, qv above. However, no other planet than Mercury has ever been portrayed as a two-faced wayfarer.

5) *Fifth condition.* If we see a male wayfarer with a crescent (or crescent-shaped horns) on his head, the planet in question is Saturn. Let us remind the reader that this conclusion was made by N. A. Morozov after his study of the Round Zodiac of Dendera. Morozov noticed that the planetary figure with a crescent on its head was also carrying a scythe in one of the cases – a well-known attribute of Saturn. This is how Saturn was portrayed in the ancient astral symbolism, qv above.

6) *Sixth condition.* The sign of circle stands for either the Sun or the Moon in Egyptian zodiacs.

The fact that a circle contains a crescent doesn't necessarily identify it as the Moon. Such circles can

just as easily symbolise the Sun – possibly, in order to emphasise that a new moon is always "born" in the vicinity of the Sun. Also, a circle without a crescent doesn't necessarily stand for the Sun – it can also refer to a full moon, which is observed as a disc and not a crescent.

However, an independent crescent that isn't part of a circle must by all means represent the Moon.

Due to such similarity between solar and lunar symbols in Egyptian zodiacs, the issue of which circle stood for which celestial object was usually solved by simple computer calculations involving all possible variants. All identification options of circles (solar and lunar) were considered equally possible.

Let us conclude with a list of certain specific traits of Egyptian planetary symbolism in zodiacs, which haven't been known previously. They weren't accounted for in decipherment. Such traits manifested in the course of our astronomical calculations and the comparison of resulting solutions.

Falcon's head – Mars. If the zodiac in question contains a planetary figure with the head of a falcon and without any other distinctive characteristics, it can be identified as Mars. In general, Mars was drawn with a falcon's head more often than any other planet in Egyptian zodiacs.

The head of an ibis – Saturn or Mercury. A planetary figure with the head of an ibis identifies as Saturn or Mercury in Egyptian zodiacs, qv above.

Jackal's head – Saturn or Mercury. Jackal's head might also identify a planetary figure as Saturn or Mercury, qv above.

Bull (or a bull's head) – Saturn. The bull-shaped sign or hieroglyph stands for planet Saturn. In some of the Egyptian zodiacs (those from Dendera, for example), Saturn has apparently got the head of a bull.

Goose – Mars. The goose is a symbol of Mars in Egyptian zodiacs. It was usually depicted next to the head of a planetary figure, or under its feet. In the latter case, the Goose stood for Mars in a secondary horoscope, simultaneously acting as a transposition sign, qv above.

Lioness – Venus. The lioness is a symbol of Venus in Egyptian zodiacs, qv above.

Crocodile – Venus (in a number of cases). In some of the zodiacs, the sign of the crocodile appears to symbolise Venus, qv above.

11. OBSERVATION POINT: CAIRO OR LUXOR (IBRIM)?

The visibility of planets may depend on the observer's position in certain cases. Let us remind the reader that the visibility of certain planets is indicated in Egyptian zodiacs, and therefore has to be verified in the analysis of astronomical solutions. Sometimes the observer's location can affect the calculation results.

We have used Cairo in Egypt as the assumed observer's position in our calculations. Moreover, in ambiguous cases we have also checked planetary visibility for the Egyptian city of Luxor on the Nile, some 500 kilometres further south than Cairo. Luxor was chosen as the possible observer's location due to the fact that the temples of Dendera and Esna, where the large ceiling zodiacs were found, are located in its immediate vicinity. Moreover, the royal necropolis is very close to Luxor on the Nile. Royal tombs were carved in the rocks of the nearby hills. The ceilings of some tombs were also decorated with zodiacs.

As it has already been stated, Egyptologists identify the Egyptian city of Luxor as the ancient Thebes, the city described in detail by Herodotus. It must be noted that in several ancient Russian maps the loca-

Fig. 15.78. Egypt on a Russian map of the XVIII century entitled "Drawing of the Terrestrial Globe". The actual compilation date is absent from the map, but its publishers date it to the middle of the XVIII century. We see the town of Ibrib (Abram = Abraham?) on the site of Luxor, where the city of Thebes is presumed to have been located. This is where the Nile makes a great turn and forms the great bight, known as "Bight of the Kings". This is also the location of the royal graveyard, concealed from sight in the hills. Map fragment from [306:1].

Fig. 15.79. A close-in of a fragment of the previous illustration. We see the Egyptian town of Ibrim (Abram = Abraham?) and the "Bight of the Kings", or the royal necropolis of the Nile bight. Map fragment from [306:1].

tion of Luxor (or Thebes) is occupied by the city of Ibrim ([306:1], fig. 15.78). The name "Ibrim" is very similar to that of Abraham. Therefore, Luxor (or some city close nearby) was once known as the "City of Abraham". This may be owing to the fact that the Biblical Abraham was considered the founder of the Empire's royal dynasty. At any rate, we can see that the royal cemetery was located next to the city that was formerly known as Abraham's City, or Ibrim (see fig. 15.79). It must also be said that modern maps of Egypt tell us nothing about any geographic location called Ibrim.

12. THE BEGINNING OF A YEAR IN EGYPTIAN ZODIACS

Since an Egyptian zodiac was the astronomical description of a whole year that the zodiacal date falls on, it was important to find out what date the ancient Egyptians used to mark the beginning of a year. Nowadays, years are counted off January, but this hasn't always been the case. The beginning of a year could be chosen in a variety of ways for different times and geographical locations. In the Middle Ages, for example, New Year could come in March or September. There were other dates for starting a year as well. When did the Egyptian year begin?

Let us consider the actual Egyptian zodiacs first of all. Apparently, there are no explicit indications of this sort anywhere – it might be that the Egyptian New Year symbolism remains beyond decipherment to date. Nevertheless, the beginning of a year as observed by the authors of a given zodiac can be calculated reliably enough. Judging by the order of constellations on the zodiacs, the New Year started in the constellations of Leo and Virgo – the month of September, in other words.

Indeed, let us consider the rectangular zodiacs once again: the Long Zodiac of Dendera (DL), the Lesser Zodiac of Esna (EM) and the Greater Zodiac of Esna (EB), figs. 12.13, 12.14, 12.20 and 12.18.

In the Lesser Zodiac of Esna the entire zodiacal row is stretched into a single procession of constellations and planets. It is therefore easy enough to find the zodiacal constellation that opened the year – it must lead the procession. Unfortunately, the part that must depict the beginning of the procession is missing. But even the remaining part suffices to conclude that the leader of the procession is the constellation of Virgo, which means that the Egyptian year began in September.

The situation with the Long Zodiac of Dendera and the Greater Zodiac of Esna is somewhat more complex, but it is possible to make a conclusion nonetheless. In each case, the zodiacal procession is divided into two parts (see figs. 12.13 and 12.14). Therefore, there can be two candidates for leadership among the constellations depicted on these zodiacs.

In the Long Zodiac of Dendera it's either Leo or Aquarius (see figs. 12.13 and 12.14). There are close ties between the symbols of Leo and Virgo in this zodiac (which is the case with many other Egyptian zodiacs as well). Therefore, strictly speaking, we should name the Leo-Virgo couple as the first constellation here.

In the Greater Zodiac of Esna the constellation that leads the procession is either Virgo (Leo) or Pisces (see fig. 12.18).

A final comparison of all cases tells us that the first constellation in the "annual procession" of constellations and planets in Egyptian zodiacs must have been Virgo. In other words, according to the zodiacs, the Egyptian year began in September. No other Egyptian zodiacs known to us contradict this conclusion.

Apparently, the conclusion made on the basis of our purely formal analysis of the Egyptian zodiacs is

in perfect correspondence with the known peculiarities of Egyptian climate. According to N. A. Morozov, the September beginning of the year must have truly been an Egyptian tradition, since it is defined by the annual floods on the Nile ([544], Volume 6, page 641). N. A. Morozov has put forth the proposition that the custom of beginning the year in September, which the Russian Orthodox Church managed to preserve for so many years, came to the Orthodox East (and Russia in particular) from Egypt ([544], Volume 6, page 641).

It has to be said that the Russian Orthodox calendars in Church Slavonic indicate the 1st September (old style) as follows: "Beginning of the Indiction, or the New Year". Before the reforms of Peter the Great, Russians celebrated New Year in September.

Therefore, Egyptian year began in autumn – September, to be more precise. The day of autumn equinox in September fell over the New Year already, since the symbols of autumn equinox are at the head of the annual procession (see the zodiacs in figs. 12.13, 12.14, 12.20 and 12.18. More details concerning the symbolism of the vernal equinox point can be found in fig. 15.61 above.

Consequently, the annual order of equinoxes and solstices as implied by the Egyptian zodiacs was as follows:

1) Autumn Equinox in September – beginning of the year.

2) Winter Solstice in December (same year).

3) Spring Equinox in March (same year).

4) Summer Solstice in June (end of the year).

We have referred to this very sequence of solstice and equinox points in our analysis of the year's secondary horoscopes – assuming the year to begin in September, that is. All the astronomical solutions that we have discovered satisfy to the secondary horoscopes under the assumption that the Egyptian year began in September.

Nevertheless, we didn't consider September to be the mandatory beginning of a year. In order to make the solutions more reliable, we have checked concurrence with secondary horoscopes for all possible beginnings of a year. However, in final solutions the year turned out to begin in September (insofar as the zodiac in question permitted to calculate it in the first place).

CHAPTER 16

Astronomical estimation of the dates ciphered in the Egyptian zodiacs: a methodology

1. SEVEN PLANETS OF THE ANTIQUITY. ZODIACS AND HOROSCOPES

Nowadays we know seven planets – Jupiter, Saturn, Mars, Venus, Mercury, Uranus and Neptune. However, Uranus wasn't known to ancient astronomy since this planet is too dim for the naked eye to see. It was discovered by the English astronomer William Herschel in 1781 – already in the telescope observation epoch, that is ([85], Volume 33, page 168) – let alone Neptune.

Therefore, ancient astronomers were familiar with only five of the planets known to us today, Uranus and Neptune excluded. However, before the heliocentric theory of Copernicus became widespread, the Sun and the Moon were ranked among planets as well. Hence the "seven planets of the antiquity" that we shall be referring to.

Let us explain why the Sun and the Moon were considered planets before Copernicus. According to the old astronomical theories, all celestial bodies revolved around the Earth and not around the Sun. From the point of view of an observer from Earth, it is the latter that every celestial body revolves around, and not the Sun. The trajectories of the Sun and the Moon also look very similar to those of the planets. Thus, the pre-Copernican astronomy didn't distinguish between the Sun, the Moon and the planets in their movement across the celestial sphere.

It is possible that at dawn of astronomy people had thought all seven luminaries that one sees on the celestial sphere to move inside a real sphere of cyclopean proportions, with all the immobile stars affixed thereto in some way. After many years of observation, ancient astronomers discovered that all these luminaries follow the same imaginary itinerary as they move along the celestial sphere. They realized that this itinerary follows an extremely large circumference upon a sphere and doesn't change with the course of time (today we know that it does change, but very slowly, and cannot be noticed with the naked eye). The planetary itinerary on the celestial sphere is known as the ecliptic, or zodiacal belt in astronomy. The constellations located along it are called the zodiacal constellations.

Thus, according to the old beliefs, which were apparently shared by the authors of the Egyptian zodiacs as well, seven planets or "wandering stars" were constantly moving across the sphere of their immobile cousins. These "wanderers" are as follows: *the Sun, the Moon, Jupiter, Saturn, Mercury, Mars and Venus.*

The habit of ranking the Sun and the Moon among planets died hard. In fig. 16.1 we reproduce a

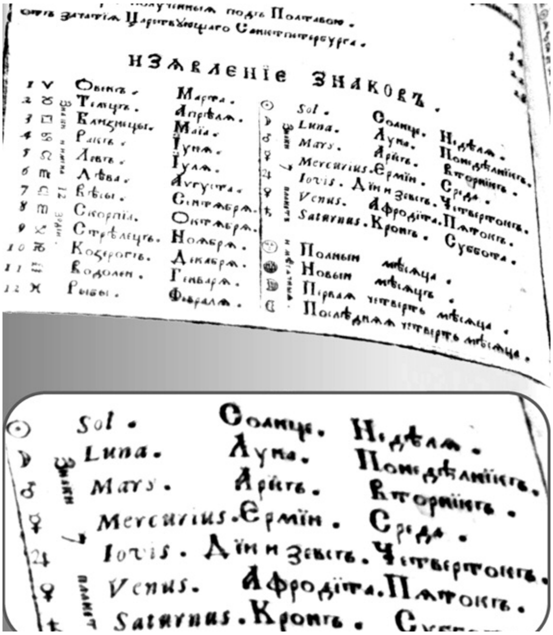


Fig. 16.1. A page from an ancient XVIII century calendar dating from the epoch of Queen Anna Ioannovna. At the bottom of the drawing we cite a close-in with a list of the seven planets, including the Sun and the Moon. Both Greek and Latin names are cited – names of the gods identified with planets, as well as days of the week related to the planets in ancient astronomy. The names of planets are as follows: Mars = Ares, Mercury = Ermis (Hermes), Jupiter – Dyis or Zeus, Venus = Aphrodite, Saturn = Kronos. Photograph of a calendar kept in the State Hermitage in St. Petersburg, taken in 2000.

page from a XVIII century calendar where the Sun and the Moon are still referred to as planets.

All the planets except for the Sun, and occasionally also the Moon, can only be seen at night – that is, when one cannot see the Sun whose light outshines all the other celestial bodies. The Sun, on the contrary, is only visible during the day. The Moon can be seen at night, and sometimes also in the daytime. Each of the seven planets is located in one of the zodiacal constellations at any one time.

The distribution of the seven planets in question across the Zodiacal constellations is called a horoscope.

Egyptian zodiacs are ancient Egytian drawings of the celestial Zodiac with Zodiacal constellations drawn thereupon symbolically. Quite often one would find planets, and thus also a horoscope, in the Egyptian zodiacs. Apart from that, a zodiac could contain auxiliary astronomical symbols as mentioned above. Most often there's just a single full horoscope in an Egyptian zodiac; however, there are some that contain several horoscopes. There are also horoscope-less zodiacs in existence.

Each planet's position in relation to the constellations of the zodiacal belt can be observed in the sky, the Sun being the sole exception. All the planets are visible at night, likewise the stars, except for the ones that have come too close to the Sun, which temporarily deprives them of nocturnal visibility. Their position on the Zodiac is nevertheless easy enough to estimate – they should be near the Sun.

The Sun's place on the zodiac cannot be observed; it is, however, possible to determine it. One can do it at dawn or immediately after dusk. For instance, one can mark the place where the sun sets in the evening and then, when it gets dark enough, also mark the zodiacal constellation that appears here. This requires the knowledge of the Sun's daily motion speed determined by the rotation of the Earth – a value that remains constant over the course of time (within the precision limits that interest us, at least). Therefore, the speed at which the Sun sets is easy enough to calculate – all it takes is a clock, no matter how roughly-made.

There is another simple method of estimating the position of the Sun among the stars with precision. It couldn't be used any day, though – only during full moon, and on the condition that the stellar longitudes on the Zodiac have already been measured by someone. Were the ancient astronomer in the possession of such a catalogue, he could estimate the position of the Sun by that of the Moon. One should bear in mind that the Sun and the Moon are on the opposite ends of the Zodiac during full moon; therefore, once we mark the position of the full moon amongst the stars, we can use the catalogue of zodiacal constellations in order to find the zodiacal point that opposes it, where the Sun shall be.

The knowledge of the Sun's position during full moons and the fact that the speed of the solar ecliptic motion remains constant throughout the entire year of the solar cycle, one can calculate the celestial position of the Sun for any day. Once again, one needs to have some sort of a timekeeping device and the

knowledge of fractions; both appeared in the Middle Ages (METH3]:3, pages 94-102).

Let us emphasise that no matter how the observations are conducted, the position of the Sun among the stars can always be calculated. To reiterate – one cannot observe the Sun and the stars simultaneously, yet the position of the Sun in the Egyptian zodiacs is usually indicated with precision. Therefore, the zodiacs could simply be compiled, without the need for observing celestial objects and performing astronomical calculations.

2. THE POSSIBLE PRESENCE OF CALCULATED HOROSCOPES IN EGYPTIAN ZODIACS

And so, the ancient astronomers could estimate the zodiacal positions of every planet except for the Sun from immediate observations. The position of the Sun either had to be calculated, or could only be given very roughly. Therefore, the horoscopes from the ancient zodiacs could be compiled from actual observations.

On the other hand, nothing could prevent the ancient astronomers from calculating the horoscopes that they would subsequently write into one zodiac or another. This would require an astronomical theory of some sort in order to enable one the calculation of every planet's position and not just the Sun with any degree of precision at all – not that high, the correct indication of a planet's position as related to a constellation could easily suffer the error rate of 5-6 longitudinal degrees. Such precision requirements were well met by Ptolemy's theory, for instance, as related in the "ancient" Almagest ([704]). By the way, it is presumed that the Almagest was written in Alexandria, Egypt ([704]).

Don't forget that Scaligerian chronology dates the Almagest to the II century A.D. We have demonstrated this dating to be erroneous, as well as the fact that the Almagest was compiled between the VII and the XIV century A.D., and then complemented and edited up until the XVII century. The "ancient" editions of the Almagest that we have at our disposal today all hail to the XVII century, qv in Part 1.

Thus, according to either the New or the Scaligerian chronology, Egyptian astronomers had a theory that sufficed for calculating and not observing the horoscopes that they included in their zodiacs.

Hence the important corollary that we already mentioned above.

A horoscope one finds in an Egyptian zodiac doesn't necessarily refer to the date contemporary to this zodiac's manufacture.

For instance, if a zodiac is a drawing from the ceiling of an ancient temple, the date ciphered in its horoscope is unlikely to be that of the temple's construction – most probably, it is the date of the holy event that the temple itself was consecrated to. Therefore, there is a very real possibility that such horoscopes were calculated during the construction of the temple and reflects the builders' ideas on the dating of the even in question.

Another possibility is as follows. The "ancient" compilers of the Egyptian zodiacs (which could have lived in the XV, XVI, and in some cases even in the XVII-XVIII century A.D., according to the New Chronology) may have known an older tradition than we and owned old books which are irretrievably lost to us. For example, they may have used the truly old records of astronomical observations dating to the XI-XIII century for reference when they compiled zodiacs for the "ancient" Egyptian temples built in their epoch.

They could also have had a really old version of Ptolemy's Almagest at their disposal, one that dated to the epoch of the XI-XIV century A.D. All we have now is a XVII century European edition that is presented to us as the "unaltered original" of the "incredibly ancient" Almagest without any justification whatsoever (see CHRON3, Chapter 11).

On the other hand, a horoscope from the ceiling of an Egyptian sepulchre or the lid of an Egyptian coffin is most likely to contain a date corresponding to the time of the actual coffin's (sepulchre's) manufacture, since such zodiacs would apparently refer to the date of birth or demise of the deceased buried here. In this situation, the horoscope could be observed on the sky and instantly written into the funereal zodiac. The only thing left to calculate would be the position of the Sun. This method may have been preferential, since it involved a great deal less calculus.

It is however also possible that the sepulchres of the aristocracy could sometimes be adorned by zo-

diacs related to some important ancient events instead of the birth or death of the buried person. Therefore, zodiacs found in tombs and sepulchres may also have been calculated – it is obvious that the horoscope of an ancient event cannot be observed and has to be calculated. This would have to be done by specialists. Quite naturally, ancient chronologists may have informed the ancient astronomers of an incorrect dating for the horoscope, since this dating would simply reflect their ideas of the past and its chronology. These ideas could easily prove erroneous. One should hardly doubt the fact that chronological errors made then would resemble the modern ones in the respect that they would make events more ancient – not the other way round. Obviously, the older a clan, the more respect it should command. Therefore, one might expect to find horoscopes compiled for anachronistic dates in the ancient tombs.

On the other hand, one finds it highly unlikely that one should find a future date on the ceiling of a temple or the lid of a sarcophagus. Therefore, if we find a zodiac with a horoscope in an ancient temple or tomb, the event it was compiled for should predate the construction of the temple or tomb in question.

3. THE MOTION OF PLANETS ALONG THE ZODIAC

Before we begin to tell the reader just how the date of an event can be represented by a horoscope with zero or very little ambiguity, let us remind the reader of some well-known astronomical facts.

Any observer of the sky at night can notice that the celestial sphere slowly rotates as a whole. Nowadays we know this to be a result of the daily telluric rotation. Our predecessors used to think there was a huge sphere with immobile stars upon it that rotated around the Earth. This sphere was called the celestial sphere, or the sphere of the immobile stars. This concept is used in astronomy to date, although no such sphere could possibly exist in reality. However, one occasionally finds it convenient to allow for the existence of this sphere hypothetically – it facilitates astronomical discussions of the visible planetary motion and reflects the way the stars are seen from the Earth.

Indeed, in comparison to the bodies from the Solar System, the stars are far enough for us to consider them to be located at an infinite distance – or, similarly, a great distance equal for all. One can therefore imagine that all the stars are located upon the surface of a gigantic sphere with the Earth at its centre. The radius of the imaginary sphere is much greater than the distance between the Sun and the Earth, and so we may just as well consider the Sun to be its centre. The planets that rotate around the Sun, including the Earth, all have the orbits of a finite radius. The entire Solar System fits into the centre of the celestial sphere, qv in fig. 16.2.

Let us forget about the rotation of the Earth for the time being. This rotation only affects the part of the celestial sphere observable from a given point upon the surface of the Earth at any one time. One can be on the sunlit part of the Earth and see the Sun, which will be otherwise obscured by the Earth and half of the celestial sphere. However, the stars and planets on the other half of the sphere will be visible, the border between the two being the observer's local horizon, qv in fig. 16.2.

Thus, the daily rotation of the Earth only defines the visibility or invisibility of either the Sun or the planets in a given point of the telluric surface. The actual horoscope, or the way the planets are distributed across the Zodiacal constellations, does not depend on this rotation. We shall however have to account for it, albeit later, when we shall be verifying the planetary visibility conditions for individual horoscopes. For the time being, let us assume the observer sees everything. In other words, let us imagine an observer who sits in the centre of a transparent Earth and sees the Sun, the planets and the stars simultaneously.

The above viewpoint makes it easy to comprehend the planetary motion across the celestial sphere as observed from the Earth. Indeed, the position of every planet, as well as the Sun among the stars (as seen from the Earth) is defined by the direction of the ray projected from the Earth towards any of the planets. If we are to presume the ray intersects with the sphere of the immobile stars at some point, this intersection point shall give us the planet's position among the stars for a given moment in time.

Since all the planets including the Earth rotate around the Sun, the ray directed from the Earth towards any of these planets (the Sun and the Moon included) shall keep rotating, qv in fig. 16.2, since the

entire segment that includes the ray shall be in motion. Thus, the sun and all the planets move in relation to the sphere of immobile stars – slowly, but at different speeds. The celestial itinerary of each planet is obviously defined by the trajectory of the point where the ray projected from the Earth crosses the imaginary celestial sphere, qv in fig. 16.2.

Let us now point out that all these rays remain in a single plane – the "orbital plane" of the Solar System. Indeed, astronomy is aware of the fact that the rotation planes of the planets are similar to each other, but don't correspond precisely. One can consider all of them to belong to approximately the same plane – the "orbital plane", that is. The intersection of this plane and the celestial sphere shall obviously be the "celestial itinerary" of the annual motion of all planets across the celestial sphere as observed from the Earth, the Sun and the Moon included.

The solar trajectory shall be the simplest. The more or less even rotation of the Earth around the sun becomes a similarly even rotation of the Sun around the Earth from the point of view of a telluric observer. This shall mean that the Sun shall travel in the same direction maintaining the same speed, making a full cycle in a year. The exact length of this time interval is known to astronomy as "the stellar year".

The trajectories of other planets are more complex and result from two kinds of rotation – the rotation of the Earth, where the segment that defines the direction of a planet begins, and the actual planet where it ends. What this results in is that planets as seen by the telluric observer occasionally stop their movement across the celestial sphere, turn back, then turn once again and continue their motion in the original direction. This is the so-called "retrograde planetary motion". It had been noticed a long time ago, and many ancient astronomers tried to explain it. One has to bear in mind that Ptolemy's "ancient" theory already described this phenomenon with high enough precision.

Here we have been referring to the annual motion of the Sun among the stars all along. As for the daily motion of the Sun – from dusk to dawn and back, it doesn't shift the Sun's position in relation to the stars and doesn't alter anything at all on the celestial sphere. In other words, it does not affect the horoscope, since the daily motion results from the rotation of the Earth and bears no relation to the configuration of planets in the Solar System. Thus, neither the Sun nor the planets shift across the celestial sphere as a result of the daily telluric rotation.

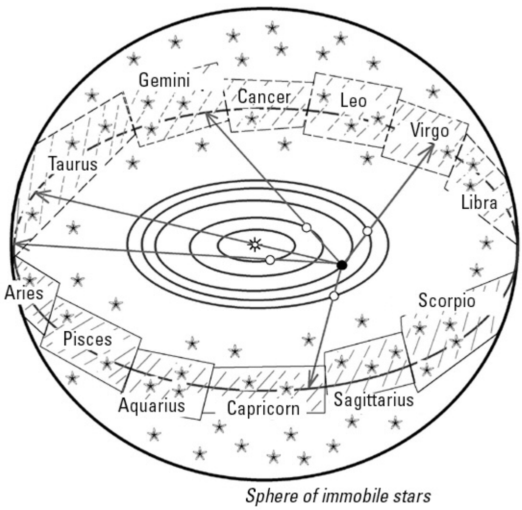


Fig. 16.2. The Solar System in the centre of the imaginary sphere whose radius is infinite – the so-called "sphere of immobile stars". The visible positions of planets in relation to the stars are determined by the intersection of rays originating on Earth with this sphere.

4. DIVIDING THE ZODIACAL BELT INTO CONSTELLATIONS

Let us briefly reiterate what we already wrote about in CHRON3, Chapter 1. In particular, let us once again present the reader with the geometry of the celestial sphere as seen in fig. 16.3. The annual motion of the Sun, the Moon and the planets follows the same circumference on the celestial sphere known as the ecliptic. The stars located near the ecliptic form zodiacal constellations. This gives us an unbroken belt of constellations that spans the entire celestial sphere, with the ecliptic seen as its hub of sorts.

More precisely, the ecliptic is the circumference where the plane of telluric rotation around the Sun intersects with the celestial sphere whose centre can be chosen as coinciding with the centre of the Sun, which lies within the plane of the ecliptic. In fig. 16.3

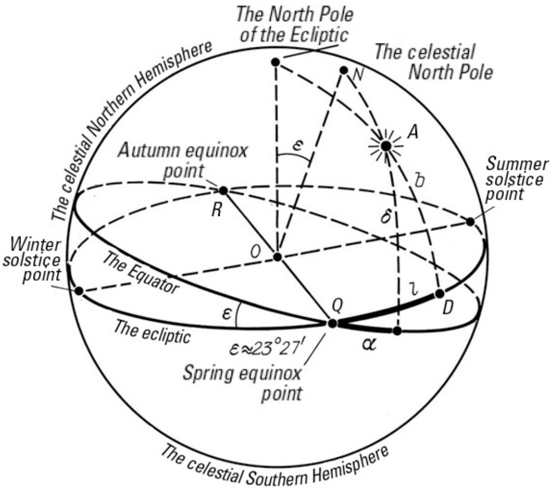


Fig. 16.3. The sphere of immobile stars, or the celestial sphere. One sees the ecliptic, the equinoctial, as well as the solstice and equinox points located thereupon. The diagram demonstrates the shifts in the celestial coordinates in an ecliptic system affixed to a certain epoch. The longitude of the point projected onto the ecliptic as counted from the spring equinox point is called the ecliptic longitude.

it is point *O*. However, we already mentioned that the distance between the Sun and the Earth, as well as the rotation of the latter, can be seen as negligible in comparison to the distance between the Solar System and the stars.

Nowadays we know that the ecliptic rotates over the course of centuries, albeit very slowly. Therefore, one has to introduce the concept of an "instant ecliptic" of a given year or epoch. For instance, the position of the ecliptic for the 1 January 2000 is called "the ecliptic of the 2000 epoch", or "ecliptic J2000" in brief.

The letter J refers to the fact that astronomy uses Julian centuries ([262] and [1222]). There is another method of astronomical timekeeping that we have used in our research – employing the *days of the Scaligerian Julian period.* Scaliger suggested to number all days, beginning with 4713 A.D. The Julian date of 1 January 1400, for instance, will equal 2232407 in this system ([393], page 316).

Apart from the ecliptic, one sees another large circumference on the celestial sphere in fig. 16.3 – the so-called equinoctial, or "the celestial equator" – the circumference where the plane of the telluric equator intersects with the celestial sphere. The equatorial circumference rotates at a great enough speed, and always changes its position on the celestial sphere.

The ecliptic and the equator intersect on the celestial sphere, the angle between them equalling approximately 23 degrees 27 minutes. The points of their intersection are marked *Q* and *R* in fig. 16.3. The Sun crosses the equinoctial in these points – twice over the course of its motion across the ecliptic. Point *Q* that marks the transition of the Sun into the Northern hemisphere, is known as the spring equinox point. Day equals night there. It opposes the autumn equinox point marked *R* in fig. 16.3. This is where the Sun enters the Southern hemisphere. Day is also equal to night here.

The winter and summer solstice points are also located on the ecliptic. Four solstice and equinox points divide the ecliptic into four equal parts, qv in fig. 16.3.

As time goes by, all four points slowly shift across the ecliptic in the direction of smaller longitudinal coordinate values. This direction is known as longitudinal precession (or simply precession) in astronomy ([262]). The rate of precession roughly equals one degree in 72 years. This shift of equinox points leads to the so-called precession of equinoxes in the Julian calendar.

Indeed, due to the duration proximity of the Julian year and the stellar year, or the time it takes the Earth to complete its cycle around the Sun, the shift of the spring equinox point across the ecliptic leads to the shift in the equinox date as given in the Julian calendar ("old style"). Namely, the Julian ("old style") date of the spring equinox keeps moving towards earlier days in March – with the approximate speed of 24 hours in 128 years, qv in fig. 14.14 above.

In order to estimate the positions of the celestial bodies one needs to know their coordinates on the celestial sphere. Astronomy has several such coordinate systems. We shall need ecliptic coordinates, specified in the following manner (see fig. 16.3).

Let us consider the celestial meridian that crosses the ecliptic pole *P* and a given point *A* on the celestial sphere whose coordinates need to be estimated. It shall cross the ecliptic plane in a certain point *D*, qv in fig. 16.3. Arc *QD* shall then refer to the ecliptic longitude of point *A*, whereas arc *AD* shall stand for its ecliptic latitude, *Q* being the spring equinox point.

Thus, the ecliptic longitudes on the celestial sphere are counted from the spring equinox point of the epoch whose ecliptic we have chosen in the present case. In other words, the ecliptic coordinate system on the celestial sphere directly relates to a certain fixed date. However, having fixed the ecliptic once, and chosen a certain coordinate system on the celestial sphere, we can specify the positions of the Sun, the Moon, the planets and any celestial body in general for any moment in time.

In our calculations for estimating the coordinates on the celestial sphere we have used the ecliptic for 1 January 2000 (J2000).

We choose the ecliptic division J1900 (1 January 1900) to represent the approximate basis for differentiation as suggested by T. N. Fomenko ([912:3], page 782). This division was performed in accordance with the star chart and the constellation boundaries specified therein ([293]). Rendered into the coordinates of the J2000 epoch, this division shall look as follows:

Zodiacal constellation	*Longitudinal interval on ecliptic J2000 in degrees*
Aries	26 - 51
Taurus	51 - 89
Gemini	89 - 118
Cancer	118 - 143
Leo	143 - 174
Virgo	174 - 215
Libra	215 - 236
Scorpio	236 - 266
Sagittarius	266 - 301
Capricorn	301 - 329
Aquarius	329 - 346
Pisces	346 - 26

It has to be said that the zodiacal boundaries on the celestial sphere are anything but clearly-specified. Therefore, any separation of the ecliptic into zodiacal constellations is approximated to some extent, and arbitrary to boot. For instance, the separation of the ecliptic into zodiacal constellations as suggested in [393], page 26 (see fig. 14.14) is slightly different from the one that we suggest above. However, simple calculations demonstrate that the difference doesn't exceed five arc degrees, which equals to the value of the solar shift over five days. What one must take into account whilst making the comparison is the fact that in fig. 14.14 the positions of the sun separate the ecliptic into days and not degrees.

Thus, both division methods are roughly coincident. We see a similar division in the mediaeval astronomical map by A. Dürer as cited above, in fig. 15.2. The differences are once again within the limits of 5 arc degrees.

We had to account for the boundary between zodiacal constellations being arbitrary. We used two methods in order to account for it.

Firstly, the program that we wrote for astronomical calculations of horoscope dates would automatically add a 5-degree "allowance interval" to the boundaries between constellations. In other words, no "border trespassing" between any pair of constellations was considered such within the limits of 5 arc degrees.

Secondly, in our interpretation and decipherment of the zodiacs and the search for preliminary astronomical solutions we would always specify wider boundaries for planetary intervals as specified in the zodiacs – namely, planets were allowed to cross the border of the adjacent constellation by half of the constellation's ecliptic length.

This would completely eliminate the possibility of losing the correct solutions due to minor discrepancies in constellation border specifications. This would naturally yield a number of extraneous solutions, which would nevertheless fail to pass the phase of secondary horoscope and planetary visibility compliance testing.

Apart from that, in the last stage of our research each of the final solutions we came up with was verified with the aid of the Turbo-Sky software so as to make sure all the planetary positions satisfy to the conditions specified by the original Egyptian zodiac. However, there wasn't a single case of poor correlation between the planetary positions as specified in the zodiac and revealed to us in the final solution. In other words, every solution that we have discovered – that is, all the solutions that withheld the test of the secondary horoscopes and planet visibility indicators, turned out to be in perfect correlation with their

respective zodiacs planetary disposition-wise. Let us however reiterate that in the initial search this correlation was tested under less strict criteria.

5. "ASTRAL CALENDAR". HOW OFTEN DO INDIVIDUAL HOROSCOPES RECUR?

Let us give a more in-depth account of the astral calendar used by the ancient Egyptian astronomers and artists in order to transcribe dates in the zodiacs, and particularly its modus operandi. We already mentioned that in order to transcribe a date, an Egyptian zodiac should contain the positions of all seven planets, including the Sun and the Moon.

One might wonder whether there are enough possible ways of distributing planets across the zodiac in order to use the horoscopes for transcribing dates – possible horoscopes that could all be successfully assigned to dates, that is, with the discrepancy threshold of a day or two?

Let us perform a brief calculation. A year has 365 ¼ days, which makes a millennium equal some 365 thousand days. The historical period covered by documented history equals 5-6 thousand years, according to the consensual chronology. It is easy enough to calculate that the period in question equalled to circa two million days. Can the quantity of horoscopes available to us cover an interval this great? Could there be so few possible planetary combinations to make individual horoscopes recur every 100-200 years? Had this been the case, the dates transcribed with the aid of horoscopes would be useless for the purpose of independent chronological study, since it would then be easy to find a date to fit the horoscope in any given century.

Actually, this is the very error (among many others) made in the attempts to prove Scaligerian chronology by rough astronomical dating of Sumerian tablets ([1287] and [1017:0]) or Egyptian zodiacs ([1062], [1062:1] and [1290:1] in the interpretation that the Egyptologists suggest). See also CHRON3, Chapter 13:5.

However, let us return to the number of possible horoscopes. Fortunately, the situation is far from being as dire as one may have initially thought. The number of possible combinations for a horoscope is vast – it surpasses 3.5 million. This is quite sufficient for the purposes of independent dating.

Indeed, let us perform the following simple calculation. Bearing in mind that each of the seven planets can be in any of the 12 Zodiacal constellations at any one time, we have 12 options for every planet. However, the inner planets (Venus and Mercury) cannot lie too far away from the Sun. Thus, the maximal distance between the Sun and Venus is 48 arc degrees, and Mercury is never further away from the sun than 28 degrees ([376]). If the position of the Sun upon the zodiac is fixed, Venus can be at the distance of two zodiacal signs from the Sun maximum, whereas for Mercury this distance is never greater than a single sign. Bear in mind that a single Zodiacal sign occupies 30 arc degrees on the ecliptic in general.

Thus, we get 5 possible zodiacal signs for Venus – the same as in case with the Sun, and two neighbouring signs at either side, and 3 possible signs for Mercury, respectively, given that the solar position is fixed. Other planets can occupy varying positions on the ecliptic, independently from the position of the Sun and each other. The final result that we get is as follows:

$$12 \times 12 \times 12 \times 12 \times 12 \times 5 \times 3 =$$
$$= 3{,}732{,}480 \text{ possible horoscopes.}$$

If we aren't after particular precision and consider one zodiac to be valid for one day on the average, we shall have to divide the resulting number by the number of days in a year, which will give us the approximate horoscope recurrent interval. Any calculator shall tell us that it equals some 10,000 years. In other words, if the distribution of horoscope combinations in time were completely chaotic, each horoscope would recur once in circa 10,000 years. However, the recurrences are far from completely chaotic – thus, having once surfaced, a given horoscope recurs once or twice over the next 1,500-2,000 years, and disappears again for tens of millennia.

Such recurrence of horoscope results from the existence of pseudo-periods inherent in the planetary configuration of the Solar System. These are false periods between the recurrences of the already perturbed solar system configurations. Each recurrence of the configuration is distorted to a greater extent than its predecessor. Such pseudo-periods aren't likely to make more than two or three cycles.

One of such pseudo-periods (854 years in length) was discovered by N. A. Morozov and subsequently studied by N. S. Kellin and D. V. Denisenko ([376]). N. A. Morozov wrote the following in this respect:

"Striving to render calculations to a possible minimum, my late colleague from the Astronomical Department of the Lesgaft State Institute of Science, M. A. Vilyev, had discovered the period of 912.9 years … and after that, I calculated that an 854-year period would work even better … We see that in the present case, characterised by high precision and multi-millenarian stability of similar geo-/heliocentric combinations of Saturn and Jupiter, all of these series and triads appeared to copy one another. However, Saturn's exact cycle equals 854.25 years and not 854, and so this planets is three degrees behind geocentrically, while Jupiter's cycle equals 854.05 years, which makes it lag behind by circa 1.5 degrees for each new series. On the contrary, we witness forestalling in both cases if we are to count the series in reverse … this cycle is also very interesting due to the fact that it makes new moons and similar lunar phases recur every eight days, and the position of Mars also remains rather stable … likewise, Venus and Mercury tend to linger here two or three times, being on the same side of the sun, to the East or to the West. However, tracing such calculations … much further in time (10 cycles, or 8,500 years) would be unwary" ([544], Volume 6, pages 706 and 708).

N. S. Kellin and D. V. Denisenko have conducted additional research of the nature of the pseudo-period discovered by N. A. Morozov, discovering that it sometimes works for the telluric observer even in cases when the planetary configuration in general alters significantly. They wrote the following:

"Over the course of 854 years Venus will make 1388 full cycles in its motion around the Sun and will advance by a further 70 degrees, whereas Mercury shall lag behind its former position by some 40 degrees. Although these shifts are much greater than those of Mars, Jupiter and Saturn (21, –1.5 and –3 degrees in general, respectively), Mercury and Venus as seen by the telluric observer 854 years later might end up in the same constellation as before, and on almost the same longitude to boot, owing to the fact that their orbital motion is faster than that of the Earth and they may thus become projected over the same point of the celestial sphere even if they occupy a different orbital position in relation to the Sun" ([376]).

The effect of these pseudo-periods is as follows: many of the horoscopes, seeing as how they manifested in the last 2-3 millennia, may recur two or three times over the historical period. From the viewpoint of astronomical dating, this leads to rather undesirable, yet common scenario where we are confronted with several solutions for the same horoscope manifest throughout the entire historical period.

However, there are usually few such solutions – two or three; sometimes one – or four, on the contrary. Thus, if we are to have any kind of non-trivial astronomical information at our disposal to characterise the desired date apart from the horoscope, we shall be left with just one complete solution. This is the case with every Egyptian zodiac known to us.

On the other hand, the abovementioned calculations imply that "random", or fictional horoscopes have no solutions on the historical interval of 2-3 millennia as a rule, which is a great deal less than the horoscope recurrence period.

Thus, the "astral calendar" of the Egyptian zodiacs is indeed capable of telling us the precise dates of the ancient Egyptian history.

Apparently, the very idea of using the "astral calendar" in order to transcribe the sepulchral dates would be based on its exceptional longevity. Indeed, this calendar, unlike every other system of timekeeping known to us, allows the transcription of dates without the need for referring to any contemporary events. It doesn't depend on the beginning of an emperor's reign, or the beginning of some other era or calendar cycle. It doesn't even depend on the timekeeping system and the way of writing numbers – in other words, there are no dependencies on anything that can be easily forgotten by the descendants.

The transcription of dates in such a calendar required neither words nor numbers; drawn figures would account for everything. The only knowledge one needs in order to decipher such a dating is that of zodiacal constellation symbols and planetary figures. One has to admit that this plan of the "ancient" Egyptians, based on the presumption that people shall remember these concepts due to the immutability of the celestial sphere, proved perfectly valid. We have

enough knowledge of the ancient astronomy nowadays to decipher the "astral" datings. Such recollections help us with the decipherment of symbols from the Egyptian zodiacs.

Thus, nowadays we are fortunately capable of reading the old "astral" Egyptian dates, albeit not entirely without effort, and find out the exact epoch that the ancient Egypt dates to.

6. THE CALCULATION OF PAST PLANETARY POSITIONS. THE HOROS SOFTWARE. Modern planetary theory precision suffices for the dating of the Egyptian zodiacs

In order to calculate the positions of the Sun, Mercury, Saturn, Jupiter, Mars and Venus as seen from the Earth, we have used the Planetap program written in Fortran by the French astronomers from the Parisian "Longitude Bureau" (*Bureau des Longitudes)* J. L. Simon, P. Bretagnon, J. Chapront, M. Chapront-Touze, G. Francou and J. Laskar. The program is based on the algorithm of calculating the planetary ephemeredes that they published in "Astron. Astrophys.", an astronomical journal, in 1994 ([1064:0]).

The Planetap program allows to calculate coordinates, radius vectors and instant speeds for the eight primary planets of the Solar System (or, rather, the Earth-Moon barycentre), Saturn, Jupiter, Mercury, Mars, Venus, Uranus and Neptune. The heliocentric planetary coordinates in the Planetap program are calculated in relation to the ecliptic plane of the epoch J2000 (Julian day JD2451545.0, qv in [1064:0]).

Planetap software developers guarantee the precision rate of 2 arc minutes or more for the heliocentric coordinates of all eight planets on the time interval starting with 1000 A.D. ([1064:0]). The precision of their program begins to waver for dates preceding 1000 A.D., but remains sufficient for our purposes up to the first centuries of the new era. Bear in mind that we shall be perfectly satisfied with the discrepancy rate of several degrees for the planetary positions as observed from the Earth. Higher precision will simply be uncalled for in the dating of the Egyptian zodiacs.

Nevertheless, in order to evade the error growth for the epoch preceding 1000 A.D., we have cut out the top parts in the decomposition of power equation compounds of average orbital elements. The trigonometric decomposition compounds that contained no growing parts were left unaltered.

The Planetap program was used as a subroutine of Horos, the computer software developed by the authors of the present book specifically for the purpose of dating Egyptian zodiacs or other ancient zodiacs of a similar type.

The Horos program uses the heliocentric planetary coordinates calculated by Planetap in order to estimate the ecliptic coordinates of Saturn, Jupiter, Mercury, Mars and Venus as seen from the Earth. The initial reference point chosen for counting longitudes is the spring equinox of the epoch J2000.

The positions of the Moon on the Zodiac were calculated by another subroutine of the Horos program which was also written by the specialists from the Parisian "Longitude Bureau", likewise Planetap.

Namely, we have used the program for calculating the lunar ephemeredes entitled ELP2000-85 (Version 1.0), written in the same Fortran language by the astronomers J. Chapront and M. Chapront-Touze from the Parisian "Longitude Bureau" (*Bureau des Longitudes,* Paris, France – see [1405:1]). The program allows for calculating the lunar position on the celestial sphere as observed from the Earth with a high degree of precision. The precision of the program claimed by the authors for the epochs closest to ours (in the version that we used) is one arc second or higher ([1405:1]). Its precision for millenarian or multi-millenarian dates is likely to be much lower. However, let us reiterate that we don't require high precision for the astronomical datings of Egyptian zodiacs since the latter specify planetary positions with a great deal of approximations. We would therefore be satisfied with precision of several degrees, which is a great deal lower than the rate offered by ELP2000-85.

With the aid of such software as Planetap and ELP2000-85 which can calculate the past positions of all the ancient planets, we have developed a new astronomical program called Horos, specially designed for the astronomical dating of ancient zodiacs. Horos requires an approximate disposition of planets in Zodiacal constellations on the input, and calculates

all possible datings applicable. If the planets are arranged on the zodiacal order in some manner specified in the source (the actual Egyptian zodiac), the program marks every date for which the planetary order satisfies to the abovementioned conditions, whether in full or partially.

The description of the Horos software and its input/output files, as well as a manual, can be found in Annexes 3 and 4. The actual application can be downloaded from one of the links specified in the bibliography.

7. THE DATING OF AN EGYPTIAN ZODIAC WITH THE AID OF ITS PRIMARY AND SECONDARY HOROSCOPES REGARDED AS A WHOLE

Let us give a step-by-step description of the procedure used for the dating of all the Egyptian zodiacs. Its primary difference from all the previously-known approaches is the fact that it is based on a new and more exhaustive interpretation of the astronomical content found in the Egyptian zodiacs.

Let us emphasise that when we mention the astronomical dating of an Egyptian zodiac, we mean the decipherment of the dates that were transcribed in these zodiacs by the ancient Egyptians, and not the actual time of their creation. Modern computing facilities allow us to reconstruct many of these dates. The manufacture date of the zodiacs themselves is an altogether different issue, and can be solved differently in each individual case. However, one can be certain enough that the date ciphered in a zodiac cannot postdate its manufacture. Zodiacs were obviously used to commemorate past events and not refer to random points in the future.

On the other hand, nothing could stop the ancient Egyptian artist from encoding some very old date in the zodiac instead of one that was contemporary to his epoch. As we mentioned above, calculating planetary positions for a given date was well within the ability of an average mediaeval astronomer, who'd had his own concept of ancient chronology as seen from his epoch – some of these concepts way well have been incorrect. Therefore, the datings we may decipher in the Egyptian zodiacs may be a result of astronomical calculations of planetary positions for some event that had already been ancient for the author of the zodiac.

And so, our procedure of astronomical dating as applied to Egyptian zodiacs is as follows.

7.1. First step. Defining the primary horoscope's planets. All possible options are considered

Step 1. We used the previously-compiled comprehensive tables of Egyptian astronomical symbols (qv in Chron3, Chapter 15:4) in order to bring out every possible option of identifying the planets in a given zodiac's primary horoscope, or decipher the zodiac's primary horoscope.

We would usually come up with several possible interpretation options. For instance, the Sun and the Moon would often be drawn with similar symbols in Egyptian zodiacs, which would result in the necessity to go through all possible identification options. Sometimes we would also find ourselves in a quandary with identifying other planets, for which we could provide no unambiguous solution at the preliminary analysis stage.

7.2. Second step. Calculating the dates for every interpretation option of the primary horoscope

Step 2. We would proceed to calculate all the dates for each interpretation option of the primary horoscope when the planetary disposition on the celestial sphere corresponded to the zodiac. This would be done with the aid of the Horos program, qv in Chron3, Chapter 16:6.

We would account for the planetary order as specified in the zodiac. As a matter of fact, it wouldn't always be defined with absolute precision – there are vague places. For instance, a planetary pair's disposition on a round zodiac would be such that no order of the respective two planets would contradict the zodiac in general. Some part of the zodiac may be destroyed, in which case the planetary order is obviously impossible to determine for the destroyed part. Therefore, we have written the Horos program in such a way so as to make it recognize all such cases.

The time interval of the calculations starts with

500 B.C. and ends with 1900 A.D. We specified the lowest boundary of the interval as 500 B.C., since, according to the consensual chronology of the ancient Egypt, the earliest zodiacs allowing for decipherment and astronomical dating (classified as "the Graeco-Babylonian type") were compiled in Egypt in the I century B.C. ([1017:1], page 40). Earlier Egyptian zodiacs are completely different, and defy decipherment so far ([1017:1], page 38). We have provided for a several extra centuries as counted backwards from the date of the first "Graeco-Babylonian" zodiacs compiled in Egypt to be on the safe side.

All the dates from the calculation interval (500 B.C. – 1900 A.D.) whose horoscopes coincide with the one contained in the zodiac (with the planetary order accounted for) would be listed as possible (preliminary) dates for respective decipherment options.

The end result was presented as a table whose every column corresponded to a single decipherment version of a given zodiac's primary horoscope. The columns contained possible (preliminary) dates calculated by the Horos program. The general amount of such dates would fluctuate from 4-5 to several dozens for some zodiacs.

It is noteworthy that we have discovered a total absence of possible dates in the first centuries of the new era for many zodiacs, which is the period most of them were compiled, according to the Egyptologists. This completely confirms N. A. Morozov's conclusion that no more or less satisfactory astronomical solutions exist for the Egyptian zodiacs in the epoch desired by the Egyptologists – the first few centuries of the new era. All the solutions from this error as suggested by various authors are so far-fetched one cannot even call them solutions ([544], Volume 6).

7.3. Third step. Solutions are tested to comply with such criteria as planetary disposition, visibility indicators and secondary horoscopes. Rejection of incomplete solutions

STEP 3. We would test each of the possible (preliminary) dates made available to us in the previous stage for compliance with the following criteria (using Turbo-Sky, A. Volynkin's astronomical application):

A) *Rigid compliance with the primary horoscope.* At this stage we would verify whether the source data (the main horoscope of an Egyptian zodiac in the present interpretation) and the real (calculated) planetary positions in Zodiacal constellations concur with each other rigidly and without any ambiguity.

The necessity for such verification arises from the fact that in our calculation of preliminary dates we would deliberately make our conditions for the intervals of possible planetary disposition on the ecliptic as lax as possible. This would be done in order to compensate for the unavoidable discrepancies and arbitrariness in the estimation of constellation boundaries.

B) *Compliance with the visibility indicators as provided for Venus and Mercury,* as well as other planets located close to the sun. See CHRON3, Chapter 15:7 for more information on visibility indicators in Egyptian zodiacs.

Planetary visibility would be checked for two observation points – the Egyptian towns of Alexandria and Luxor (located some 500 kilometres to the south of Alexandria), qv in CHRON3, Chapter 15:11, where we discuss possible observation points for the horoscopes found in the Egyptian zodiacs. In doubtful cases we would also account for possible observation points further to the north.

Planets and stars are only visible in the sky if the latter is sufficiently dark, which goes to say that the Sun should set far enough under the local horizon. However, stars and planets of varying brightness may require different celestial luminosity in order to be seen.

Let us briefly remind the reader of how the luminosity of stars and planets is measured. We shall require this below, in our discussion of the solutions applicable to individual Egyptian zodiacs.

The luminosity of stars and planets is measured by astronomers with the aid of the photometric scale of stellar luminosity. Stellar luminosity indexes are marked with the letter M. The brighter the star, the smaller the value of its photometric index. For exceptionally bright stars, the luminosity index shall be represented by a negative value; however, there are very few such stars in the sky. This concerns the brightest of stars, as well as the planets that happen to be close enough to the Sun (as observed from the Earth). Remember that the luminosity of planets depends on their position in relation to the Sun and the

Earth, since planetary light is reflected sunlight, whereas the stars shine all by themselves.

The brightest star in the sky is Sirius, or Alpha Canis Majoris. Its stellar luminosity equals M = –1.46 on the stellar luminosity scale (see [1197] and [1144]). There are about two or three other stars in the sky of comparable luminosity.

The brightest planet is Venus. Its luminosity can reach almost –5 (M = –5), and usually equals –3 (M = –3) at least. As Venus approaches the Sun, it might become very bright indeed, but then it disappears from sight altogether due to sunshine, and reappears on the other side of the Sun. This is how Venus changes visibility from morning to evening.

Other planets that approach the Sun (as observed from the Earth) attain the luminosity of 0 to –2, which is very bright on the photometric scale. Dim stars have the luminosity of +5 or +6; luminosity of +6/+7 renders a star invisible to the naked eye ([1197]).

Stars whose luminosity compares to Sirius, as well as the planets that have approached the Sun close enough, but without disappearing in its rays, are the brightest celestial objects, with Venus ruling supreme in the luminosity domain. Such stars and planets become visible when the Sun sets by 7 arc degrees under the local horizon ([393], page 16). If the Sun hasn't set this far, no planets, let alone stars, can possibly be seen – with the sole exception of the Moon, which one sometimes also see in broad daylight.

Bright celestial objects are objects whose photometric index value has the magnitude order of +1. There are few such stars in the sky – two dozens at best. The same applies to planets of average luminosity. One can see them once the Sun sets by 9-10 arc degrees.

Planets and stars of the fifth and sixth magnitude order (the ones whose luminosity index on the photometric scale equals +5/+6) are only visible in total darkness, which comes when the Sun sets under the horizon by 18 arc degrees, when the so-called astronomical twilight ends and absolute night begins ([393], page 16). This is when one can even see the dimmest of the planets.

We would therefore account for the current luminosity of planets whilst checking their visibility, with the aid of the Turbo-Sky program. In the brightness of a planet equalled M = –1 at least, it was considered visible once the Sun would set by 7 degrees or more. Luminosity value of M = +2 would render the star visible with the Sun setting by 10 degrees. Dubious or borderline cases would also be interpreted in favour of a solution. In other words, although we required precise correlation between the solution and source data, we wouldn't reject a solution for which such correlation seemed possible but not obligatory.

For instance, we would occasionally manage to estimate exact correlation between the visibility of planets on the real celestial sphere and the visibility indicators on the zodiacs partially – either for the morning or evening observation visibility of a planet, that is. Such solutions would not be rejected in the visibility indicator compliance test.

The setting of the Sun would naturally always be calculated in the direction perpendicular to the local horizon.

Let us point out that the Sun might set to a much lesser extent than the direction between the Sun and the planet at the moment when the latter intersects the local horizon (rises or sets, in other words). Indeed, the shortest arc to connect the Sun and the planet in question usually isn't perpendicular to the local horizon – therefore, using the distance between the Sun and a planet to estimate the visibility of the latter might result in a mistake. The same thing can be said about the time that passes between the rising and the setting of the Sun and the planet; its dependability insofar as the planetary visibility estimation is concerned is low, since the journey of the Sun towards the horizon might take different amounts of time for the same degree of setting, and will be largely dependent on the angle between the ecliptic and the local horizon. However, this angle differs in various parts of the Earth, and depends on the latitude of the observation point a lot.

C) *Correspondence to secondary horoscopes.*

The symbolical description of every individual horoscope present in an Egyptian zodiac would have to be in perfect correspondence with the celestial sphere of the solstice (or equinox) point for the year insisted upon by the solution in question.

Empirically, this proves to be a very strict condition which a random solution usually cannot satisfy to. One or two non-trivial secondary horoscopes suffice to eliminate all extraneous solutions (we must ex-

plain that some of the secondary horoscopes found in Egyptian zodiacs are trivial, which means they satisfy to all solutions automatically).

Another important factor at this stage is the beginning of the year used in the present zodiac. For instance, if a certain solution yields us a vernal date for the primary horoscope which we intend to test for complying with the secondary horoscope of winter solstice, our actions will depend on the beginning of the year used in the zodiac under study. If a year begins in September, for instance, we'll have to consider the winter solstice of the December that precedes the primary horoscope's vernal date. Should the year begin in January or March, it is the next December that we have to turn our attention to.

Above we already mentioned the fact that Egyptian zodiacs appear to imply September as the beginning of the year; however, one needn't exclude the possibility that some zodiac might refer to March or January as to such. Therefore, we have borne in mind the possibility of different beginnings of a year. This would be done as follows: we would initially consider the version with the year beginning in September, and consider other options in case it didn't fit. However, almost every single final solution that we came up with refers to September as the first month of the year.

8. THE "COLOURED" EGYPTIAN ZODIAC

Egyptian zodiacs leave one with the initial impression of being a complex and convoluted mixture of symbols. Its astronomical meaning is only revealed after a long and careful study.

Above we describe the basic characteristics of said meaning. Every Egyptian zodiac is usually a mixture of symbolic "layers", all referring to different things. It takes time and experience to be able to tell these layers apart, which is when one begins to understand the meaning of a zodiac.

In order to make it easier for the reader to distinguish between different symbolic layers of the Egyptian zodiacs, we shall use the so-called "coloured Egyptian zodiacs" in the present book.

Let us explain what exactly we mean by that. A coloured Egyptian zodiac is a demonstrative result of the very first stage of analysis when the symbols indicating constellations, planets, secondary horoscopes etc are already found, but it isn't yet obvious what exactly they stand for (for instance, the exact correspondence between planets and planetary figures, the precise meaning of the symbols of a secondary horoscope, and so on).

More specifically, a coloured Egyptian zodiac is a drawn copy of an Egyptian zodiac where the astronomical symbols related to different symbolic layers are highlighted by different colours. Our colour choice was perfectly arbitrary and has no ulterior meaning by itself.

1) *Red – used for Zodiacal constellations.* They specify the separation of the entire Egyptian zodiac into separate zodiacal constellations.

2) *Yellow – planetary symbols of the primary horoscope.* This symbolic layer defines the date ciphered in the zodiac, since the date we are looking for is specified as a certain disposition of planets in relation to Zodiacal constellations in the "astral calendar" that contains no numbers.

However, a coloured zodiac doesn't yet give us any understanding of a given zodiac's primary horoscope. In order to find this out, we have to specify each of the seven ancient planets as drawn on the zodiac individually, which is much more difficult that simply finding all the planetary figures of a given zodiac. Those are usually made visible enough by their usual characteristics – first and foremost, planetary rods, qv above. The actual "casting" of the planetary figures is a much finer operation, and it isn't always unambiguous.

Nevertheless, a coloured horoscope permits easy understanding of just what options we have for the primary horoscope in the present case.

3) *Blue – symbols of the secondary horoscopes.* This includes the symbols of the actual solstice and equinox points where the secondary horoscopes are concentrated, as well as the indications of planets contained therein.

4) *Brown – the ten-degree symbols.* These symbols divide each zodiacal constellation into three parts, each of which occupies some 10 degrees of the ecliptic on the average, hence the name (introduced by N. A. Morozov, qv in [544], Volume 6). Ten-degree symbols are present in the Long Zodiac of Dendera,

where they look like young women, qv in CHRON3, Chapter 15:2. However, the mere presence of the ten-degree figures unfortunately does not imply that the precision rate of the horoscopes is three times higher – it remains as it was. See a discussion of this issue in CHRON3, Chapter 15:2.

5) *Green – auxiliary figures for the planets of the primary horoscope, as well as additional astronomical symbols.* See examples in CHRON3, Chapter 15.

6) *Symbols left uncoloured* – ones whose meaning is unknown to us, or makes little sense, as well as the symbols bearing no apparent relation to the date that we're trying to decipher.

In cases when it wasn't quite obvious just which symbolism layer a given symbol pertained to, it was divided into parts and coloured in accordance with existing possibilities. Different interpretation options that would arise in this case were added to the list of possible decipherment options, and subsequently verified by the Horos program.

Coloured drawings of zodiacs will be given in the sections on the dating of individual Egyptian zodiacs. Their appearance in the present book is as follows: illustrations in colour were replaced by black and white equivalents (C1-C12), with the following colour codes: *R* for red, *J* for yellow, *B* for blue, *G* for green and *BR* for brown.

9. UNAMBIGUOUS RECONSTRUCTION OF THE DATES TRANSCRIBED IN THE EGYPTIAN ZODIACS. FINAL (EXHAUSTIVE) SOLUTIONS

All three steps of the abovementioned dating procedure would either invalidate all preliminary solutions we would come up with for Egyptian zodiacs, or leave us with just one solution. Cases with more solutions were extremely rare, and all pertain to uninformative or largely destroyed zodiacs.

The resulting solution is the one we call final, or exhaustive for a given zodiac.

If the primary horoscope of an Egyptian zodiac was deciphered correctly in the preliminary analysis stage (step 1) – as one of the versions, at least, it would, as a rule, leave us with a single final solution satisfying to everything drawn in the zodiac.

In cases where we ended up with no correct decipherment of the primary horoscope in any version, given that said zodiac contained a single non-trivial secondary horoscope at least, we would come up with no final solutions whatsoever. This would be the case when we found new methods or symbols used in the zodiac under study, which would bring us to step 1 and new efforts to decipher the zodiac in question.

The important thing is that the procedure of decipherment and dating of the Egyptian zodiacs as suggested by the authors permits the unambiguous reconstruction of the dates ciphered therein with the aid of the ancient "astral calendar" in most cases.

As we shall witness below, all these dates turn out mediaeval.

10. THE "CONSTELLATION SCALE" OF A ZODIAC

The very construction of the Egyptian zodiacs doesn't provide for specifying planetary positions with high precision. All Egyptian horoscopes are but approximated descriptions of how the planets were positioned in relation to the constellation figures.

However, in order to conduct astronomical calculations, we have to specify the possible planetary disposition intervals in degrees of ecliptic longitude. This is a difficult enough task from the sight of the Egyptian zodiacs, since they contain nothing that resembles a degree scale. Therefore, if we want to specify planetary positions in degrees, we shall have to conduct some simple yet rather arduous calculations.

In order to avoid this, we have written the Horos program in such a way that the planetary positions it gets on the input wouldn't be specified in degrees of longitude, but rather the way they are read from an Egyptian zodiac, which only allows us to make such statements as "this planetary figure is drawn in Virgo, or the half of Libra adjacent to Virgo", or "this planet is in Aries or, more likely, its border, since one-third of the figure trespasses into the neighbouring constellation" etc.

Remember that when we intend to decipher a zodiac, we always make the criteria defining the borders of possible planetary disposition as lax as possible in the initial stage so as to avoid losing the correct solution inadvertently. The extraneous solutions that we come up with are subsequently rejected in the

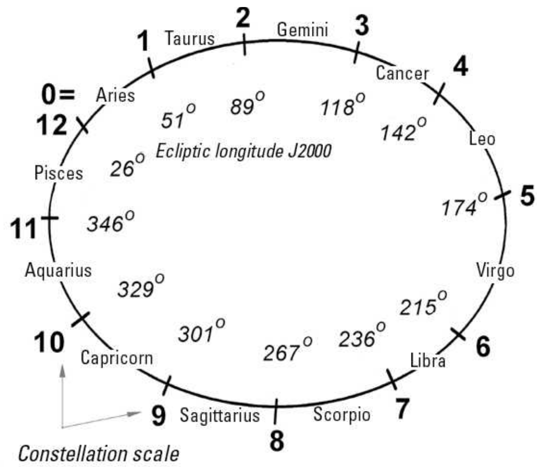


Fig. 16.4. The cyclic "constellation scale" for ecliptic J2000. Point 1.5 on this scale refers to the middle of the Taurus constellation, for instance – or, rather, the point with a longitude of 70 degrees on ecliptic J2000. Point 13.5 has the same value on this scale, since the latter is cyclic with a step value of 12. This is the scale we shall use for reading horoscopes off Egyptian zodiacs and feeding them as input data to the Horos program, which will calculate all possible datings of said horoscopes.

course of the secondary horoscope compliance test, and the resulting solution is once again tested to be in rigid correspondence with the specifications of the Egyptian zodiac.

However, this often leaves us with such intervals as "half of Aquarius, Capricorn, or half of Sagittarius" etc.

Therefore, we shall act as follows.

1) We'll separate the ecliptic J2000 (the one that we use in our research) into 12 uneven parts. Each of them will correspond to a single zodiacal constellation. The precise boundaries resulting from this separation rendered into degrees of ecliptic longitude J2000 can be seen in fig. 16.4, and also above, in section 16.4.

2) We shall proceed to mark the boundaries between zodiacal constellations with numbers (0 to 12, qv in fig. 16.4). We come up with an uneven scale of 0-12 for the ecliptic J2000. Let us make this scale cyclic specifying 12 = 0 in order to reflect the fact that the ecliptic is a circumference for which 12 equals 0.

The resulting scale allocates a single grade for every zodiacal constellation – however, the lengths of said grades are uneven and correspond to the length of the ecliptic segments covered by zodiacal constellations.

This is our "uneven constellation scale". It looks like this:

<0> Aries <1> Taurus <2> Gemini <3> Cancer <4> Leo <5> Virgo <6> Libra <7> Scorpio <8> Sagitt. <9> Capric. <10> Aqua. <11> Pisces <12=0>

Now we are capable of using this "constellation scale" in order to specify points upon the ecliptic – for instance, 1.5 will refer to the middle of Taurus, or, more precisely, a point with the longitude of 70 degrees on the ecliptic J2000. Point 13.5 will mean the exact same thing, since the scale has a cyclic nature with a step of 12, and 13.5 – 12 = 1.5 etc.

We can specify the position of a planet on this uneven scale (half of Aquarius, Capricorn or half of Sagittarius) as the interval (8.5 – 10.5), where 8.5 stands for the middle of Sagittarius and 10.5 – for the middle of Aquarius, qv in fig. 16.4. Bear in mind that the right border value of this interval can be smaller than its left die to the cyclic nature of the scale. For instance, the interval (11.5 – 0.33) has meaning and means "middle of Pisces to the boundary of the first third of Aries".

This is the scale we shall use for specifying the boundaries of possible disposition options for every planet found in an Egyptian zodiac; this is how their coordinates should be specified for the Horos program.

11. POINTS OF APPROXIMATE PLANETARY DISPOSITION IN AN EGYPTIAN ZODIAC ("BEST POINTS") AND ACCOUNTING FOR PLANETARY ORDER

Apart from longitudinal boundaries, we shall also estimate the approximate position of a planet in the sky – that is, its position on the celestial sphere that corresponds optimally to the specifications of the respective planetary figure from an Egyptian zodiac. The related point on ecliptic J2000 shall be known as the "best point", or the point of a given planet's approximate disposition.

It is obvious that the choice of such points can be subjective to a great extent; therefore, the exact position of "best points" does not affect the rejection of solution options.

However, the mutual disposition of "best points" does affect it; their order has to rigidly concur with the order of planetary figures in an Egyptian horoscope for the decipherment version of the primary horoscope under study. For each of the calculated solutions, the planetary order on the ecliptic is compare to the "best point" order by the Horos program. The solutions that have no exact equivalents are rejected.

If the mutual disposition of two or more planetary figures in a zodiac isn't specified, all the planets as a whole have to correspond to the same "best point", in which case the Horos program will consider any order correct. However, its disposition as compared to other planets shall still be verified in accordance with the "best points" specified for this set as well as other planets.

Let us point out that the mutual planetary order is rather vague in some Egyptian zodiacs – especially those of the round type where the figures aren't presented in a line but rather scattered all across the field of the drawing.

In some cases there is nothing at all we can say about the position of a given planet on the ecliptic – for instance, when we failed to identify it as any of the figures of the Egyptian zodiac under study. In this case the disposition borders of this planet on the constellation scale must be specified as the interval 0-12. The "best point" for this planet will be equal to any number greater than 100. For the Horos program this will mean the planet is "free", that is, nothing limits its position.

If the approximate disposition point isn't specified, the Horos program notifies the user accordingly.

12. AVERAGE DISTANCE BETWEEN BEST POINTS AS THE APPROXIMATE QUALITY CRITERION OF AN ASTRONOMICAL SOLUTION

"Best points" were also used for calculating the value of the "average best point deviation". Due to the fact that there's a substantial degree of vagueness involved in the choice of the "best points" themselves, this value may serve but as an approximated indicator of how the solution concurs with the specifications of the source zodiac. However, this indicator proved quite useful.

The average deviation from best points is calculated in degrees. It results from averaging absolute values of the discrepancy between the calculated positions of the seven planets and the corresponding "best points" read off the actual Egyptian zodiac under study.

If one manages to locate all planetary figures in a zodiac successfully, the "best points" of such a zodiac should be defined with the precision of circa 15 degrees, or about one half of a Zodiacal constellation, since this is the best possible precision of planetary positions as specified in the Egyptian zodiacs. Therefore, the deviation or discrepancy rate of the "best points" is minute at 15-20 degrees, which is a high degree of precision in our case. It is satisfactory at 20-30 degrees. Larger values can only enter the final solution if some of the source data were incomplete (due to the destruction of a part of the zodiac, for instance).

Should the "best point" of a given planet remain unspecified, which means it has a greater value than 100, it can be deemed equal to the calculated position of this planet in the calculation of the average deviation. However, this could make the value of the latter much lower for the solution in questions, especially in case of there being several unidentified (vacant) planets in the source data.

This would prove awkward in the comparison of various solutions to different quantities of such vacant planets.

We have therefore used the following algorithm in order to compensate for the abovementioned effect. Namely:

1) All planets were considered as a sequence in the calculation of the average deviation.

2) Unidentified (vacant) planet would be assigned temporary "best points" until the end of the abovementioned process. It would be chosen from the averaged calculated positions of neighbouring planets for which such "best points" were already specified – either at the very beginning, or during one of the previous stages of the process.

13. AN EXAMPLE OF THE INPUT DATA FORMAT USED BY THE HOROS PROGRAM

Let us provide an example of the input file syntax (INPUT.TXT) as used by the Horos program. These data were obtained from one of the decipherment versions of the primary horoscope as read from the Long Zodiac of Dendera. The boundaries of planetary disposition and the "best points" as applicable to them were specified in the "constellation scale".

No calculus whatsoever was required for the compilation of these data into a table – they were read from the Egyptian zodiac immediately. All the calculations necessary for converting the data into the ecliptic longitude degrees from the "constellation scale" are performed by the software itself.

A SPECIMEN INPUT.TXT FILE

INPUT DATA FOR HOROSCOPE DATE CALCULATION SOFTWARE **HOROS**

SUN	MOON	SATURN	JUPITER	MARS	VENUS	MERCURY
#FROM#						
11.0	6.0	9.0	11.0	10.0	.0	.0
#TO#						
1.0	8.0	11.0	1.0	12.0	2.0	2.0
#BEST POINTS#						
11.5	7.5	9.5	12.0	11.0	.5	1.0

The file INPUT.TXT can contain any commentary – however, the configuration lines marked "# … #", immediately preceding each line of data, must remain intact, with no other lines beginning with the symbol "#" anywhere else in the text of the file. Furthermore, the order of the data lines cannot be altered.

14. VERIFICATION TABLE FOR THE ASTRONOMICAL SOLUTION

For each solution obtained as a result of astronomical calculations with the use of the Horos program we would compile a table of just how well this solution corresponds to the indications specified in the Egyptian zodiac but unaccounted for in the preliminary solution search (step 2 of our method, qv in CHRON3, Chapter 16:7).

Let us remind the reader what exactly we tested in the solution:

Visibility indicators of Venus, Mercury and other planets that end up near the Sun in the primary horoscope, qv in CHRON3, Chapter 15:7.

Correspondence to the four secondary horoscopes – of autumn equinox, winter solstice, spring equinox and summer solstice, qv in CHRON3, Chapter 15:5, CHRON3, Chapter 15:6 and CHRON3, Chapter 15:8.

Correspondence to the auxiliary astronomical symbols and scenes of the Egyptian zodiac in question, qv in CHRON3, Chapter 15:9.

We have used a verification table for this purpose, which was compiled for every preliminary solution. It would contain six or more columns with the following content:

1) Visibility of Venus in the primary horoscope.
2) Visibility of Mercury in the primary horoscope.
3) Secondary horoscope of autumn equinox.
4) Secondary horoscope of winter solstice.
5) Secondary horoscope of spring equinox.
6) Secondary horoscope of summer solstice.
7) The Passover full moon in Libra. This column only applies to the zodiacs that have a circle in Libra (or, possibly, other symbols referring to the Passover full moon).

There would be more columns for some of the Egyptian zodiacs, depending on the amount of auxiliary astronomical symbols and scenes found therein.

Each column would contain a brief description of the corresponding part of the celestial sphere that would be modelled in this solution. If the model corresponded to the source zodiac completely, we would put a "+" sign in the table cell corresponding to this column.

If we failed to estimate complete concurrence, we would use the "–" sign. Ambiguous cases also employ the "+/–" indication.

An exhaustive or complete solution would be one for which the verification table consisted of nothing but plus signs. Such solutions were declared final, with all others rejected.

Let us point out that it is everything but obvious a priory that one can find such complete, or exhaus-

tive solutions for all the Egyptian zodiacs known to us. Our demands for precision from the part of the ancient Egyptian astronomers and artists could have proven too high, or we simply could have misinterpreted the symbolism of the Egyptian zodiacs. It is obvious that in either case the probability of coming up with ideal exhaustive solutions for all zodiacs at once, as is the case with our research, would simply equal zero.

On the contrary, if our conditions for the ideal (exhaustive) solutions proved too lax, we would have several ideal solutions for different zodiacs.

Neither of the above is the case. On the contrary, our calculations demonstrated the following:

For almost every Egyptian zodiac that we studied, just one of the preliminary solutions is ideal. This is why we claim our method to yield unambiguous datings for Egyptian zodiacs in almost every case (apart from the zodiacs too poor in content, or too greatly damaged).

We would usually come up with several near-ideal solutions (all pluses and one or two minuses). However, in almost every case there is just one solution with all pluses.

Below, in the sections dedicated to the dating of actual Egyptian zodiacs, we shall cite the verification tables of their complete solutions. We were using the following abbreviations:

1) S. D. – the distance between the set sun and the horizon in arc minutes. For instance, S. D. = 10 refers to the Sun that had set by ten degrees.

The setting distance of the Sun is calculated for the moment the planet in question rises or sets, if we are referring to its morning or evening visibility. Just how far the Sun sets by that point determines the observer's ability to see this planet in the sky. If nothing else is specified, it is presumed that the setting of the Sun is calculated for the observation point in Cairo, Egypt.

Bear in mind that a planet of regular luminosity is only seen in the sky when the distance between the set Sun and the local horizon equals or exceeds ten degrees. Very high luminosity of a celestial body (–3.5 and higher) makes the planet visible with the Sun set by 7-8 degrees, qv in CHRON3, Chapter 16:7, Step 3-B.

2) M. – the luminosity of the planet specified according to the photometric scale. M = –3.2 means that the planet in question had the luminosity of minus 3.2 at the time. We already mentioned that planetary luminosity may fluctuate greatly.

Bear in mind that the luminosity of a planet as specified on the photometric scale may be a negative number – the smaller the value, the brighter the planet. Venus, the brightest planet, can attain the luminosity level of circa M = –4, although it usually fluctuates between –3 and –3.7. Luminosity of 0 to 1 is characteristic for bright stars as well as planets; planets of this visibility can only be seen together with bright stars when the Sun sets by 8-9 degrees; lower luminosity of a planet only makes it visible with the Sun set by 10 degrees and more, 18 degrees equalling to total darkness which makes the dimmest stars and planets visible. See more about it in CHRON3, Chapter 16:7.3.

3) A fractional value from 0 to 12 in parentheses – calculated position of a planet on the "constellation scale", qv in CHRON3, Chapter 16:10. For instance, 2.5 refers to the middle of Gemini, or a point with the coordinates of 70 degrees on the ecliptic J2000, whereas 0.2 would stand for a point in Aries with the longitude of 31 degrees on the ecliptic J2000, qv in CHRON3, Chapter 16:10.

4) The columns that deal with planetary visibility also occasionally specify the distance between the planet and the sun in arc degrees. This distance is specified by the capital Greek letter delta (∅).

In the free part of the verification table we draw a grid that contains as many cells as there were columns in the verification table, each of the cells containing a plus, a minus or a plus/minus sign, depending on how well the solution satisfies to the source zodiac. If the solution proves exhaustive, there should be a plus in every cell.

Apart from this, we also specify the average distance between the calculated positions of the main horoscope's planets and their "best points" near the "grid" (by "best points" we understand positions of optimal correspondence to the specifications of the Egyptian zodiac, qv in CHRON3, Chapter 16:11).

CHAPTER 17

Dates ciphered in the monumental temple zodiacs of Dendera and Esna

1. THE ZODIACS FROM DENDERA AND ESNA AS PART OF THE GRANDIOSE ROYAL NECROPOLIS IN THE "ROYAL BIGHT" OF THE NILE

In the middle of the Nile's current, near the Egyptian city of Luxor, one finds the enormous royal graveyard dating to the epoch of the "Egyptian Pharaohs", carefully hidden from the profane eye. The site is a vast space with hills galore, which consist of soft rock. There are many ravines here that conceal ancient tombs, including those of kings, all cut into the rocky slopes of a near-inaccessible mountain valley known as "Valley of the Kings" (see figs. 17.1, 17.2 and 17.3). The famous tomb of Tutankhamen is also located here, by the way, qv in fig. 17.4. This entire upland area is located in the gigantic bight on the western bank of the Nile, qv in fig. 17.5. It is possible that this place was once known as the "Bight of the Kings", since this is where we find the royal necropolis of the Ancient Egyptians.

The modern Egyptian city of Luxor can be found right across the Nile, on the eastern bank of the river. Egyptologists are of the opinion that Luxor had once been the famous "ancient city of Thebes" ([499]). This is possible. Let us also point out that the very name Luxor may be Slavic in origin, derived from "*Luka Tsarey*" ("Bight of the Kings").

Luxor and the nearby Egyptian town of Karnak is where we find the two gigantic "ancient" Egyptian temples named after the two respective towns, qv in figs. 17.6 and 17.7. Both these fortress-like temples stand on the eastern bank of the Nile, whereas on the western bank, on the side of the necropolis, one sees the two cyclopean stone effigies of sitting pharaohs. These are the famous "ancient" colossi of Memnon, qv in fig. 17.8. They appear to guard the road that leads towards Luxor from the royal graves, qv in fig. 17.9. All these constructions appear to have been part of the royal necropolis as a single funereal complex.

Several other ancient temples that one finds nearby must have belonged to the same complex, among those the temple of Dendera named after the city where it is located ([2], fig. 17.10). In fig. 17.11 one sees a relatively recent photograph of several ancient constructions from Dendera. The modern Egyptian town of Esna is a little bit further down the Nile. It is considered to stand on the site of the "ancient Latopolis". Several temples with zodiacs are located nearby ([2]).

The town of Dendera can be found in the actual "Bight of the Kings", and Esna is close nearby, qv in fig. 17.5.

The two towns from the vicinity of the royal necropolis in the "Bight of the Kings" is where the gigantic stone zodiacs that we shall discuss further in

Fig. 17.1. "Valley of the Kings" (Biban-Al-Muluk) – one of the mountain gorges in Luxor, or the Bight of the Kings, where one finds royal tombs. 22 sepulchres have been discovered here to date ([499], page 44), including the tomb of Tutankhamen. A view of the entrance into the gorge from a dead end. Photograph taken in 2000.

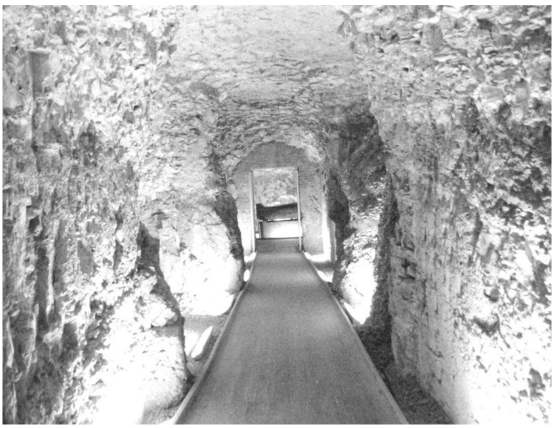


Fig. 17.2. "Valley of the Kings" (Biban-Al-Muluk). A passage carved through the body of the rock leads from the entrance to the tomb that houses the sarcophagus with the mummy. There is a wooden floor here nowadays, for the convenience of the tourists. Photograph taken in 2000.

Fig. 17.3. "Valley of the Kings" (Biban-Al-Muluk). The burial chamber with the sarcophagus. The wooden floor is modern. There is no mummy in the sarcophagus. When Europeans first came here (already after the Napoleonic expedition), all the sarcophagi stood empty, with their lids open, with neither mummies nor valuables inside them. Photograph taken in 2000.

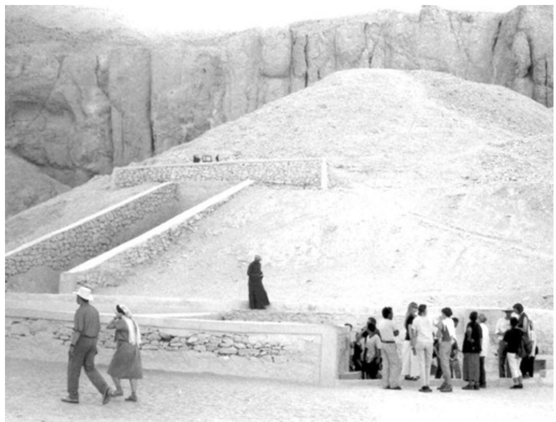


Fig. 17.4. "Valley of the Kings" (Biban-Al-Muluk). The mound over the tomb of Tutankhamen. Another royal sepulchre was made in the side of the mound. Photograph taken in 2000.

the present chapter were discovered. They come from the ceilings of the two temples. There are four such zodiacs altogether (there may be others in existence, but they remain unknown to us). Each one of them has got a certain date ciphered therein, which may relate to the holy events that said temples were consecrated to. The proximity of both Dendera and Esna to the royal necropolis gives us reasons to believe all of these zodiacs to be of a funereal nature. If so, it would be most edifying to learn whom they are supposed to commemorate, as well as the temples where these zodiacs are found. Let us point out that the zodiacs from Dendera and Esna are much bigger than all of the Egyptian zodiacs found in the sepulchres of the "Valley of the Kings". Furthermore, their style differs from that of the tomb zodiacs considerably.

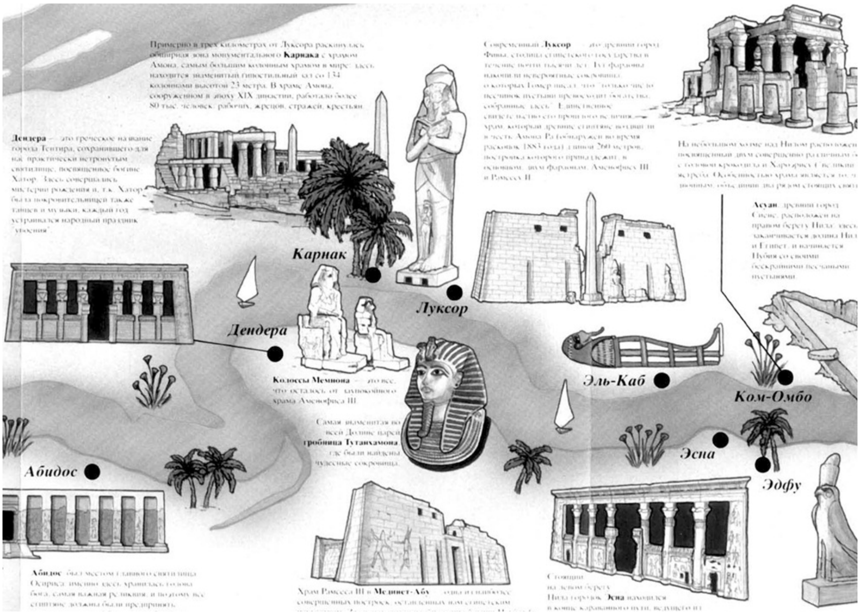


Fig. 17.5. A part of a modern tourist map of Egypt demonstrating the valley of the Nile where it forms a gigantic bight known as the "Bight of the Kings", or Luxor. The tombs of the Great Empire's rulers (also known as Egyptian pharaohs) were concealed in the hills here. The map has an icon here that looks like Tutankhamen's golden mask. Let us point out that the orientation of temples and other monuments as given in this map is rather arbitrary, and their locations are rather approximate. Taken from [370], inset at the end of the book.

The zodiacs from the sepulchres of the "Bight of the Kings" can usually be classified as belonging to the "Theban type" – which is only appropriate seeing as how Luxor is considered to be the "successor of the ancient Thebes", qv above.

Zodiacs of the Theban type can be seen in figs. 12.1, 12.3 and 15.25 above. They are simple murals – paint over plaster. Their interpretation is usually a rather difficult task, since constellation figures were usually omitted from such zodiacs, qv above. Unlike them, the zodiacs of Dendera and Esna contain easily identifiable constellation figures, and their symbolism is a great deal easier to understand.

As we mentioned previously, in order to represent a certain date as an "astral calendar" transcribed in a zodiac, ancient Egyptians only needed to know a modicum of astronomy. If the date in question had been contemporary to them, they could calculate nothing and simply observe the planets on the celestial sphere whenever the need would arise. However, the solution of the reverse problem, or decoding the dates transcribed as zodiacs, is anything but an easy task. Nevertheless, nowadays we have all the means required for it.

In the following sections of the present chapter we shall tell the reader about how we deciphered the dates from all four zodiacs from Dendera and Esna. As you may remember, all these dates turned out mediaeval, which means that the "ancient" Egyptian builders were of the opinion that the holy events commemorated by the construction of the two temples had taken place in the Middle Ages. The zodiacs from the temples of Dendera date from the late XII century A.D., and the ones from Esna – to the late XIV – early XV century. The temples themselves could therefore only have been built later than these dates.

This result is naturally an absurd one from the point of view of the modern Scaligerian chronology. Nevertheless, it appears to be true.

On the other hand, the dates we came up with ideally fit the framework of the New Chronology which was reconstructed by the authors of the pres-

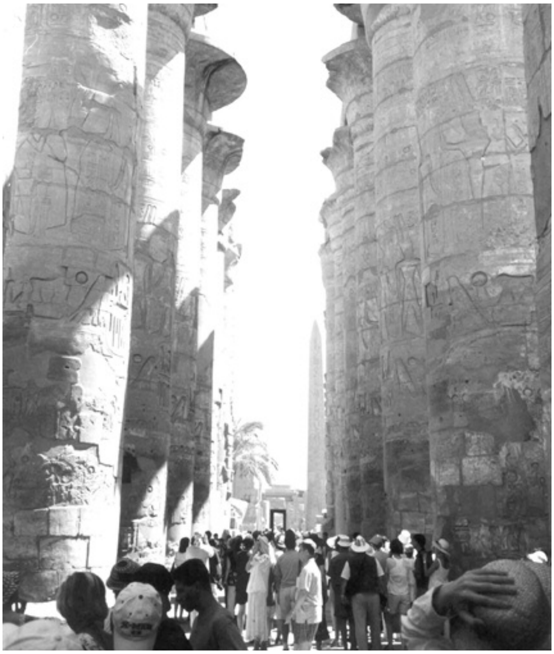


Fig. 17.6. The funereal pathway inside the Karnak temple lay between two rows of cyclopean columns that one can still see there. Photograph taken in 2000.

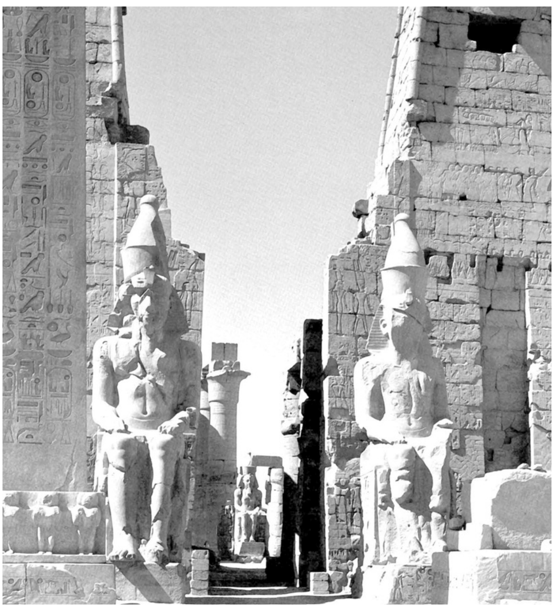


Fig. 17.7. Entrance to the Temple of Luxor. This is where the funereal procession arrived after passing through the sphinx road that led here from the Karnak temple. Taken from [499], page 8.

Fig. 17.8. The two colossi of Memnon "guarding the gigantic pylon of the temple where Amenothis III was buried" ([370], page 136). One sees gigantic Orthodox Christian crosses on the backs of the thrones that both statues are sitting on. It is presumed that these monuments were erected in the XIV century B.C. The hair on the head of the figure is woven into a braid. The colossi of Memnon stand on the western bank of Nile in Luxor, or "The Royal Bight". They stand on a plain, but the hills begin several miles behind their backs. Those hills and mountains conceal the royal sepulchres. Taken from [370], page 137.

Fig. 17.9. Modern road built in the hills of Luxor (Bight of the Kings). It leads to the Biban-Al-Muluk gorge, where numerous royal sepulchres were found. Photograph taken in 2000.

Fig. 17.10. A drawing of the Dendera temple from the Napoleonic Egyptian album. This is how it was seen and drawn by the artists who came to Egypt with Napoleon's army. Taken from [1100], A. Vol. IV, Pl. 7.

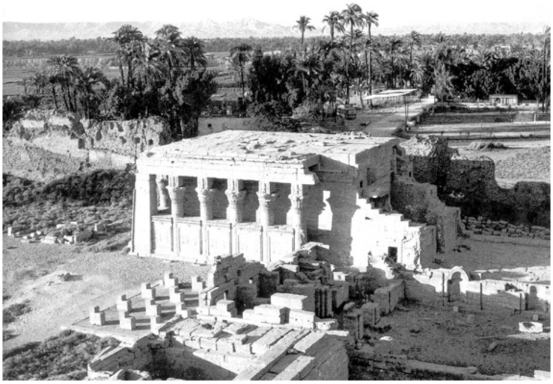


Fig. 17.11. Modern view of the ancient Egyptian constructions in the town of Dendera located in the Egyptian "Bight of the Kings". Taken from [2], page 55.

ent work with the aid of empirico-statistical and astronomical methods based upon the entire body of documented information that we had at our disposal, qv in Chron1-Chron3.

2. THE ZODIACS OF DENDERA: HISTORY OF DISCOVERY AND RESEARCH

The Long Zodiac of Dendera is a ceiling bas-relief carved in stone. Its size is 25 by 42.5 metres. It was discovered by the Europeans on the ceiling of a gigantic hypostyle hall in the "ancient" Egyptian temples of Dendera.

The first estimations made by the Egyptologists about the age of the temple claimed that it predated the new era by 15 thousand years ([370], page 162; also [544], Volume 6, page 651). The dating was subsequently shifted to the beginning of the new era, qv in [544], Volume 6, page 651.

The entire ceiling of the hypostyle hall in the temple of Dendera where the Long Zodiac was discovered is covered in "ancient" Egyptian artwork, its content being astronomical for the most part. Both halves of the Long Zodiac that represent the celestial zodiac as a whole are rows of images one sees on either side of the ceiling. They span the entire space of the ceiling that appears to symbolise the celestial sphere, qv in fig. 12.15 above.

The second Dendera zodiac (the Round one) is a ceiling bas-relief carved in stone, measuring 2.55 by 2.53 metres. It was found in the antechamber of the same temple in Dendera and taken away to Europe; the original of the zodiac is kept in the Louvre nowadays ([1062], page 6).

This is how the entire history of the discovery and the subsequent study of the Dendera zodiacs by the Europeans was related in the 1930's by N. A. Morozov, who had researched these zodiacs meticulously ([544], Volume 6, pages 651-694).

"Dendera is a small town in Egypt that lies to the north of Thebes [modern Luxor – Auth.] on the banks of the Nile, with the population of some 9-10 thousand people.

The ruins of Tentyris, an ancient city, are located nearby; they include the remnants of a temple that can be considered truly splendid for that epoch. By the end of the XVIII century there had still been two well-preserved sculptural pieces of artwork on the ceiling. The first one, known as the Round Zodiac, comes from the temple's dome and was taken to Paris; the second one comes from the temple's antechamber and is known as the Rectangular Zodiac [the one we refer to as the Long Zodiac – Auth.]. There was a great amount of research conducted followed by many publications; the town of Tentyris became Dendera in the process" ([544], Volume 6, pages 651-652).

In Chapter 12 we mentioned that the first Egyptologists dated the Temple of Dendera to the fifteenth millennium before Christ, no less. Then its dating started to shift "upwards", having subsequently "frozen" at the III millennium b.c. Then historians suggested to consider the Long Zodiac to date to the epoch of Tiberius (14-37 a.d.), and the Round Zodiac

– to the epoch of Nero (54-68 A.D.). When astronomers tried to verify these dates with astronomical calculations involving the horoscopes contained in the zodiacs, the results proved negative. These planetary horoscopes didn't appear until the III century A.D. There were two solutions – either to date the imperial Roman reigns to other centuries, or declare the horoscopes to be of a fantasy nature. Egyptologists were most reluctant to contradict the Scaligerian tradition and chose the latter, despite the fact that, according to N. A. Morozov, "the veracity of both horoscopes becomes blatantly obvious as soon as we exclude the introductory religious processions" ([544], Volume 6, pages 651-652).

N. A. Morozov lists these processions. We shall omit his list, since he mistook the symbols from the secondary horoscopes of the Dendera zodiacs for "extraneous religious scenes", which he erroneously considered to bear no relation to either the astronomic content of the zodiac or the problem of its dating.

N. A. Morozov also informs us of the following:

"All the other figures with staves represent planets and constellations, and some of them can be identified immediately as follows:

In the rectangular zodiac [the "Long Zodiac" of Dendera – Auth.], for instance, we see a lone figure of a man bearing a staff, which identifies it as a planet, and the head of a falcon in Pisces, closer to Aquarius, with an inscription near his head saying Hor-Tos, which stands for "red planet", according to Brugsch (also known as Hor-Teser or Hor-Tesher) – Mars, in other words.

In the very same constellation of Pisces we see another man with a falcon's head – somewhat to the right, though, closer to Aries, bearing a planetary rod and wearing a luxurious tiara, with an inscription saying Hor-Apis-Seta, standing for "planet Jupiter".

In Aries we see a wayfarer in a head priest's headdress, bearing a rod, which means the figure in question is planetary. The double-faced head (one of the faces being aquiline and the other human) could identify the planet as Mercury whose faces can be seen on either side of the sun – however, according to Brugsch, we see the inscription saying Phouter-Ti (god or goddess of the morning), which identifies the figure as Venus. However, one may well doubt his guess. On the right of this figure we see the symbolic representation of the dusk and the dawn – two little animals with their backs grown together. We see two young women bearing rods right above, one with a human face and the other with a canine snout [it is leonine and not canine – one of the symbols pertaining to Venus, qv in CHRON3, Chapter 15:4.8 – Auth.]: this must be the double representation of Venus as the morning and evening star.

Between Libra and Scorpio one sees the full Moon drawn as a circle, with a young woman carrying a staff inside. This is clearly a reference to a full Moon in May [actually, in this position the reference isn't necessarily to a full Moon in May, but always a vernal one which either takes place in March, April or May – Auth.].

All the other stars and planets are defined just as explicitly in the Round zodiac from the palace temple of Dendera [N. A. Morozov is exaggerating a trifle bit here, qv below – Auth.].

If all of this is nothing but the artist's fantasy, it is hard to explain the fact that in both zodiacs Mercury and Venus are in their rightful place, near the Sun, and not in some other impossible location which would nevertheless be convenient for the artists. Also, why would they want to draw a fantasy horoscope, anyway?" ([544], Volume 6, pages 652-653).

Let us point out that both ideas voiced by N. A. Morozov in re the zodiacs from Dendera proved to be perfectly correct. However, due to the fact that he hadn't managed to decipher the Egyptian astronomical symbolism completely, N. A. Morozov came up with an erroneous answer, misdating the Dendera zodiacs to the VI century A.D. ([544], Volume 6, page 651). See CHRON3, Chapter 13:1 for more details.

3. DECIPHERING THE DATE OF THE LONG ZODIAC OF DENDERA (DL)

3.1. The Long Zodiac of Dendera and the various representations thereof

As it was pointed out, the attempts to date the Long Zodiac of Dendera astronomically were made in the numerous works of the XIX-XX century. It was studied by Dupuis, Laplace, Fourier, Letron, Holm, Biot, Brugsch, B. A. Turaev and N. A. Morozov ([544],

Volume 6, pages 655-672), and more recently N. S. Kellin together with D. V. Denisenko ([376]) as well as T. N. Fomenko ([912:3]). We mentioned this research in CHRON3, Chapter 13.

The research conducted by N. A. Morozov, N. S. Kellin and D. V. Denisenko, and T. N. Fomenko, involved a great body of work on deciphering the astronomical content of the Dendera zodiacs. We shall be referring to the results of this research.

At the same time, we appear to be the first to have noticed the existence of secondary horoscopes in Egyptian zodiacs. This very fact allowed us to eschew the "optimal interpretation problem" in our efforts to date the Egyptian zodiacs. Our approach involves all possible interpretations at once, without the need to choose the "best one" the way our predecessors had to do. They were doomed to trust rather ambiguous considerations in order to decide which one of the two equally possible interpretations was better than the other. This problem does not exist in our approach. See more on our method in CHRON3, Chapter 16:7.

In the dating of the Egyptian zodiacs it is necessary to use copies of high enough quality with the sufficient amount of detail. The use of low quality copies of the Egyptian zodiacs can lead to mistakes in their interpretation, and false datings eventually.

In the Napoleonic Egyptian album ([1100]), the Long Zodiac from Dendera occupies a rather large amount of space; we see both a drawn copy of the zodiac and a detailed shaded copy, qv in figs. 12.11-12.14 above.

Bode's ***Uranography*** (XIX century) contains a copy of a substantially lower quality (see figs. 13.3 and 13.4 above). This is the copy that N. A. Morozov had used in his research of the Dendera zodiacs ([544], Volume 6). However, T. N. Fomenko discovered several errors and distortions in this copy; they happen to affect the astronomical dating most ostensibly. Morozov came up with a wrong result in his dating of the Long Zodiac; a more detailed account can be found in CHRON3, Chapter 13.

A modern photograph of the Long Zodiac's small fragment that gives one an idea of what the original looks like can be seen above, in fig. 12.16.

In the present chapter we shall need a much more detailed rendition of the Long Dendera Zodiac than the ones found above. In figs. 17.12 – 17.15 one finds a detailed drawn copy of the Long Zodiac, with all of the details that we shall be mentioning below represented thereupon.

Let us give a step-by-step account of how we dated the Long Zodiac of Dendera (see CHRON3, Chapter 16:7).

3.2. The Long Zodiac of Dendera in colour

Step 1, qv in CHRON3, Chapter 16:7.1. The interpretation of the Long Zodiac's primary horoscope and the compilation of a "coloured zodiac".

The compiled tables of Egyptian astronomical symbols as cited above in CHRON3, Chapter 15, helped us to identify the figures of planets and constellations from the primary horoscope in the Long Zodiac of Dendera, qv in CHRON3, Chapter 15:1, and CHRON3, Chapter 15:4. We compiled the coloured version of the Long Zodiac as a result – see figs. C1, C2, C3 and C4; the colours are represented by the following codes: *R* for red, *J* for yellow, *B* for blue, *G* for green and *BR* for brown. Below, in our discussion of the Long Zodiac, we shall presume the reader to possess a both the "coloured zodiac" and simple drawn copies (see figs. 17.12-17.15).

3.3. Constellation figures in the DL zodiac

Constellation figures are shaded red in figs. C1, C2, C3 and C4; the colour is represented by the letter *R*. All the constellations are easily recognizable – they look conspicuously canonical. Our interpretation of the zodiacal constellation symbols in the Long Zodiac doesn't differ from the respective interpretation as found in the works of Egyptologists – [1062], for instance.

The same interpretation was offered in the work of N. A. Morozov ([544], Volume 6), the work of N. S. Kellin and D. V. Denisenko ([376]) and the work of T. N. Fomenko ([METH3]:3, Chapter 12).

3.4. Planetary figures of the primary horoscope from the DL zodiac

Planetary figures of the primary horoscope are shaded yellow (letter *J*) in figs. C1, C2, C3 and C4. Among them we find every single figure of a wayfarer

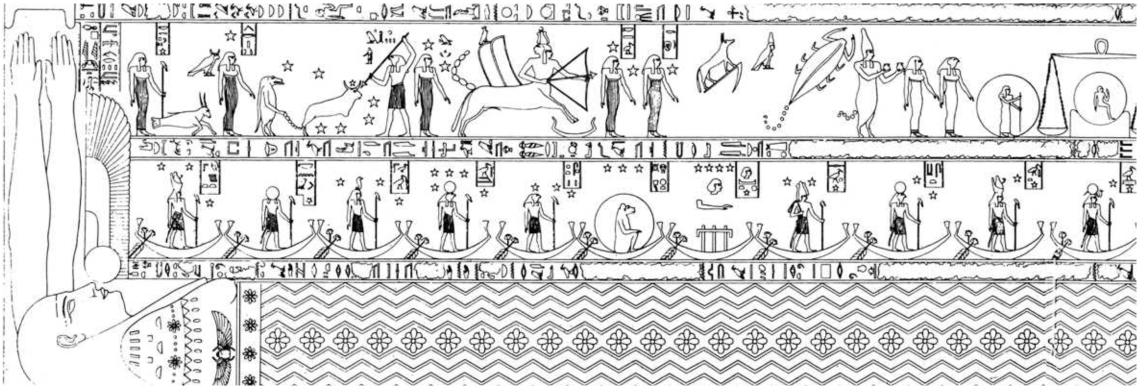


Fig. 17.12. The Long Zodiac of Dendera (DL) according to the drawing from the Napoleonic Egyptian album. Part one. Taken from [1100], A. Vol. IV, Pl. 20.

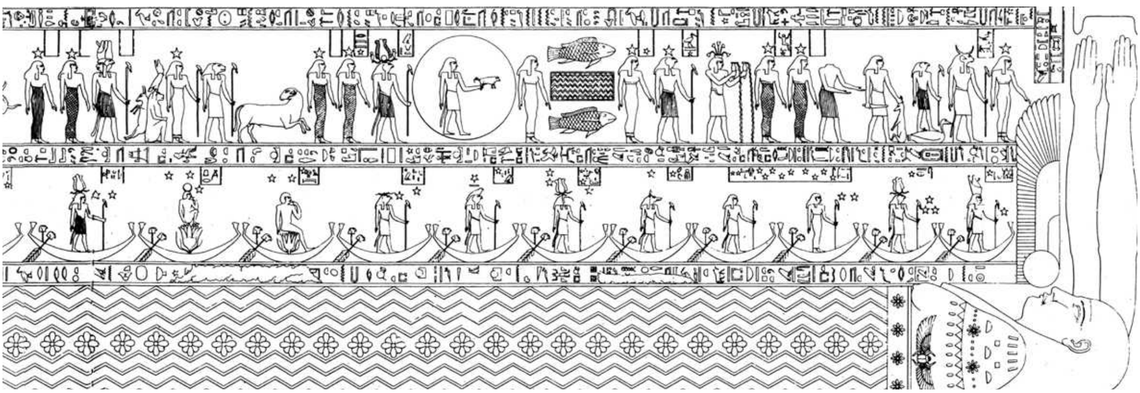


Fig. 17.13. The Long Zodiac of Dendera (DL) according to the drawing from the Napoleonic Egyptian album. Part two. Taken from [1100], A. Vol. IV, Pl. 20.

with a planetary rod found in the zodiac, *apart from the ones that either stand on certain objects or rest their rods upon them*.

As we explained in CHRON3, Chapter 15, planetary figures either standing or resting their rods on other objects bear no relation to the primary horoscope, qv in CHRON3, Chapter 15:6. These figures pertain to either secondary horoscopes or auxiliary symbols, and are as follows in the Long Zodiac:

1) Young woman whose planetary rod rests upon the back of Capricorn's figure.

2) The man with the head of a falcon, holding a planetary rod and standing over the figure of a goose. We see him between the figure of Aquarius and the edge of the zodiacal strip.

3) The man with a planetary rod standing in a boat between the constellation of Gemini and the edge of the zodiac.

4) A pair of women in a boat near the very end of the zodiac, left of Gemini. The one in front is holding a staff whose shape differs from that of a regular planetary rod from elsewhere in the Long Zodiac – it is topped in a different way. Nevertheless, we may have considered this figure as part of the primary horoscope if it hadn't stood in a boat.

In order to avoid confusion, let us point out that the object held that the figure of Virgo (marked with letter *R* for red in the coloured zodiac) is holding an ear of wheat in both hands – not a rod. Virgo was always drawn holding an ear of wheat – in the Egyptian

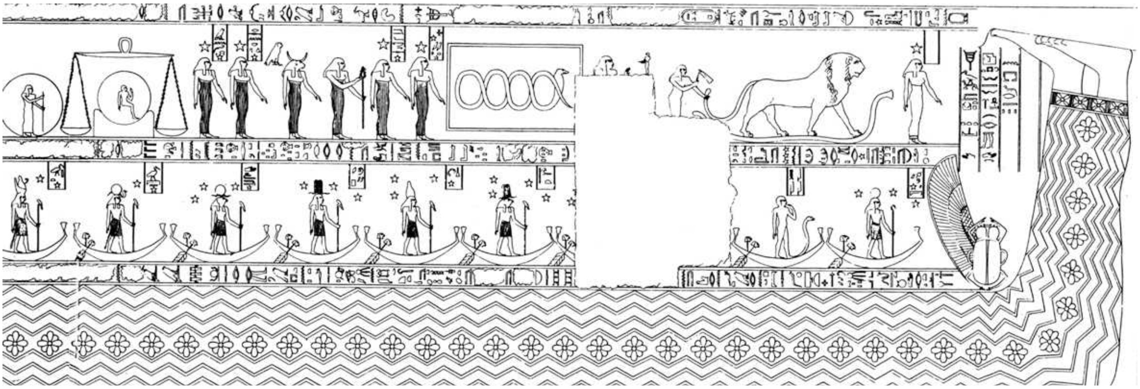


Fig. 17.14. The Long Zodiac of Dendera (DL) according to the drawing from the Napoleonic Egyptian album. Part three. Taken from [1100], A. Vol. IV, Pl. 20.

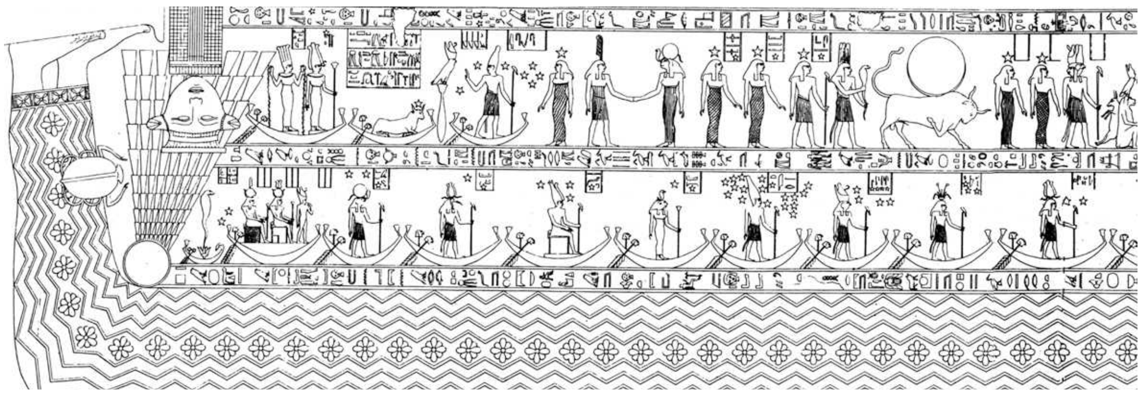


Fig. 17.15. The Long Zodiac of Dendera (DL) according to the drawing from the Napoleonic Egyptian album. Part four. Taken from [1100], A. Vol. IV, Pl. 20.

zodiacs, likewise the ancient European ones, qv in Chron3, Chapter 15:1.

Let us now turn to the woman holding a long stick in both hands – the one we find inside a circle near Libra. The circle is shaded yellow (letter *J*) in the coloured zodiac, since we have a planetary figure in front of us. Don't forget that circles were used to refer to the Sun and the Moon in the Egyptian zodiacs; however, planetary rods weren't used in their case, qv in Chron3, Chapter 15:1. The long stick in the hands of this woman isn't an Egyptian planetary rod since it has a different top part, qv in Chron3, Chapter 15:4.1 where we discuss the shape of planetary rods in Egyptian zodiacs. Also pay attention to the fact that the stick is held in both hands, whereas all the planetary figures found in the Long Zodiac hold the rod in just one hand.

All the other figures with rods in figs. C1-C4 (apart from the exceptions listed above) are shaded yellow (letter *J*), since they are the planets from the primary horoscope. Let us provide a list.

Saturn – the male wayfarer with a planetary rod in his hand, to the right of Aquarius, near the very edge of the zodiac. He has a crescent or a pair of crescent-shaped horns on his head. See more on just why this figure stands for Saturn in the primary horoscope in Chron3, Chapter 15:4.2.

Our identification of Saturn in the Long Zodiac coincides with the one made by T. N. Fomenko in her work ([912:3]) and those written by Egyptologists –

see [1062], for instance. N. A. Morozov identified Saturn differently; however, this can be explained by the fact that he had used an imprecise copy of the Long Zodiac. See more details in CHRON3, Chapter 15:4.2.

Thus, Saturn in the primary horoscope of the Long Zodiac is either in Aquarius or Capricorn; therefore, the area of allowable positions for Saturn spans the constellations of Aquarius and Capricorn.

The figure of Saturn is separated from Aquarius by five other figures, and can be found at the very edge of the zodiacal strip. The figure we see drawn as walking in front of Saturn, the first one in this strip, marks a ten-degree segment of Capricorn. Therefore, the "best point" (approximate disposition point) for Saturn in the Long Zodiac can be considered to equal the boundary between Aquarius and Capricorn.

Bear in mind that a "best point" is the position of a planet that is the closest to the one found in the zodiac. These points are used in order to determine the planetary order in a given zodiac, as well as calculation of the average planetary location deviation. Average deviations, or discrepancies, are used for the approximate comparison of solution but play no part in their rejection, qv in CHRON3, Chapter 16:2.

Let us now consider all the other planets.

Jupiter is the male wayfarer with a planetary rod that we see between Pisces and Aries. We see the inscription saying Hor-Apis-Seta over his head, which stands for "the planet Jupiter", according to Brugsch ([544], Volume 6, page 652.

Our identification of Jupiter in the Long Zodiac coincides with the ones offered by N. A. Morozov ([544], Volume 6), N. S. Kellin and D. V. Denisenko ([376]) and T. N. Fomenko ([912:3]), as well as the one suggested by Egyptologists ([1062]). See more details in CHRON3, Chapter 15:4.6.

Thus, Jupiter in the primary horoscope of the Long Zodiac is shown either in Pisces or in Aries. Therefore, the area of Jupiter's possible locations in the astronomical solution is limited to the two abovementioned constellations.

The figure of Jupiter in the Long Zodiac is separated from both Pisces and Aries by a similar amount of figures – two on each side. Therefore, let us consider the boundary between Pisces and Aries to be the "best point" for Jupiter.

Mars is a male wayfarer with a falcon's head and a planetary rod in his hand seen between Pisces and Aquarius. The inscription near his head says Hor-Teser (Hor-Tos or Hor-Tesher) – "the red planet", according to H. Brugsch's translation, or Mars ([544], Volume 6, page 652).

Our identification of Mars in the Long Zodiac corresponds with the one suggested by N. A. Morozov ([544], Volume 6), N. S. Kellin and D. V. Denisenko ([376]), T. N. Fomenko ([912:3]) as well as the Egyptologists ([1062]). See CHRON3, Chapter 15:4.7 for more details.

Thus, Mars in the primary horoscope of the Long Zodiac is shown either in Pisces or Aquarius. The possible astronomical solution area will thus include the constellations of Pisces and Aquarius.

Since Mars in the Long Zodiac is separated from Pisces by the ten-degree female figure and is immediately adjacent to Aquarius, we shall consider the middle of the latter to be the "best point" for Mars.

Venus is represented by the pair of wayfarers holding planetary rods in between Aries and Taurus. The man with the head of a beast (lion?) is in front, followed by a woman with a star over her head, which is the only female planetary figure in the Long Zodiac.

Consequently, Venus in the primary horoscope is shown in either Aries or Taurus; these constellations comprise the possible position area for Venus in the astronomical solution.

Our identification of Venus in the Long Zodiac coincides with that of N. A. Morozov ([544], Volume 6), N. S. Kellin and D. V. Denisenko ([376]) as well as T. N. Fomenko ([912:3]); however, it differs from the identification of the Egyptologists ([1062]). However, insofar as other Egyptian zodiacs are concerned, the Egyptologists de facto agree with Morozov and us ([1291]). See more on the identification of Venus in CHRON3, Chapter 15:4.8.

Visibility indicators are very important for both Venus and Mercury, qv in CHRON3, Chapter 15:7. The figure of Venus in the Long Zodiac has a star over its head, which implies that Venus was visible.

Venus and the corresponding planets are separated from Taurus by two ten-degree figures of young women and one planet (Mercury, qv below). The procession is immediately adjacent to Aries; therefore, the middle of Aries shall be considered the "best point" for Venus.

Mercury is the double-faced male wayfarer holding a planetary rod in between Aries and Taurus. He has no star over his head – no visibility indicator, in other words. For Mercury this means invisibility in the rays of the Sun, qv in CHRON3, Chapter 15:7. Thus, Mercury was invisible during the days covered by the primary horoscope.

However, Mercury re-appears on the very same horoscope in a visible position.

Pay attention to the pair of male wayfarers between Taurus and Gemini. The one in front has a cobra in his hands, and the one behind him carries a planetary rod and has a visibility indicator (a star over the head).

The second figure looks like a canonical primary horoscope figure, and should therefore refer to some planet. However, all the planets were already listed, excluding the Sun and the Moon which were drawn as circles and not wayfarers, qv in CHRON3, Chapter 15:4.13-15.

This pair of male wayfarers is in close proximity to the already discovered figure of Mercury. They may therefore serve as another representation of Mercury and are unlikely to refer to any other planet, since other planets lie too far away from this location.

The snake in the hands of the wayfarer in front also identifies him as Mercury, qv in CHRON3, Chapter 15:4.10.

Why would Mercury have to be drawn twice?

One can only give a finite answer after analysing the astronomical solution. One may however assume that, since the visibility indicators are lacking from the first figure of Mercury (meaning that Mercury was invisible in the main horoscope's configuration), the artist also wanted to show the position where Mercury first becomes visible or looks the most spectacular.

Another option is to consider one of Mercury's figures part of a respective secondary horoscope. Both of them look vaguely like secondary horoscope figures; indeed, the rod of the two-faced figures is conspicuously hanging over the legs of the neighbouring little animal that stands for the dawn, although without touching it. This case can therefore be considered borderline between the presence and the absence of a transposition sign (rod leaning against another object). As for the pair of male figures following Taurus, both staves would be regular planetary rods if said figures stood for Mercury in the primary horoscope, as is the case with Venus in the same zodiac. Both Venus and the figure that accompanies it carry planetary rods of the ordinary kind. In case of the "second Mercury" we see the second figure hold a snake rather than a rod. Therefore, what we see in case of the "second Mercury" is another borderline occasion, strictly speaking.

Therefore, in our computation of solutions applicable to the Long Zodiac we considered all of the abovementioned options to be viable. Furthermore, we tried to consider all other possible identifications of this auxiliary planetary figure ("the second Mercury"). However, we came up with no identifications that would make an exhaustive solution of the Long Zodiac feasible.

See more in re Mercury in the Egyptian zodiacs and its two positions in CHRON3, Chapter 15:4.11.

Thus, Mercury in the primary horoscope of the Long Zodiac is drawn either in Aries/Taurus (the two-faced figure), or in Taurus/Gemini (the figure with a star). Therefore, the possible solution area for Mercury in the astronomical solution includes Aries, Taurus and Gemini.

The "best point" for Mercury shall lay at an equal distance from both planetary figures representing Mercury – in between the two. Thus, the "best point" for Mercury falls over the middle of Taurus.

We have covered all the planetary figures of the Long Zodiac that look like wayfarers. There are no other figures with planetary rods. Let us now consider the celestial bodies drawn as circles.

The Sun and the Moon. If the issue with the abovementioned primary horoscope planets could be solved without any ambiguity whatsoever, the case of the Sun and the Moon is a lot more complex.

In the works of N. A. Morozov, T. N. Fomenko and the Egyptologist Sylvia Cauville ([1062]), the figures of the Sun and the Moon from the Dendera zodiacs were identified perfectly differently. If we are to disregard the details, the reason can be formulated simply: there are four circles in the Long Zodiac; each of them is fit to represent the Sun or the Moon. However, the primary horoscope only requires two circles to represent them.

However, our approach eliminates this problem. Since we are aware of the existence of secondary horoscopes in the Egyptian zodiacs, we shouldn't be wor-

ried about the "extra" circles of the Sun and the Moon. The problem of choosing two circles out of four is solved very simply – we sort through all possible choice options and proceed to analyse all the resulting astronomical solutions as equal. The full solution that we shall end up with finally shall demonstrate which circles should stand for the Sun and the Moon in the primary horoscope. Other circles must pertain to secondary horoscopes, with nothing extraneous present anywhere in the zodiac.

Previous works on the dating of the Long Zodiac didn't account for secondary horoscopes; their authors were forced to make a choice of two circles out of four possibilities to represent the Sun and the Moon. This introduced an aleatory element into the calculations and compromised the integrity of the results, qv in CHRON3, Chapter 15:4.13 – 15.

Thus, there are four circles in the Long Zodiac:

1) The circle with an infant sucking on its thumb in Libra.

2) The circle with the figure of a female holding a long stick near Libra.

3) The circle with a man who holds some animal in his hands, with his arms stretched forward as if he were making an offering of this animal near Pisces, on the side of Aries.

4) The circle on the back of Taurus. This circle has no indications; there is a narrow crescent near one of its edges. However, this doesn't necessarily identify the circle as the Moon; such circles could also stand for the Sun in the Egyptian zodiacs, qv in CHRON3, Chapter 15:4.13-15. Another option is that the circle represented both the Sun and the Moon simultaneously. We have accounted for this version in our calculations, but came up with no exhaustive solutions.

The most likely candidates for the Sun in the primary horoscope were seen as either the circle on the back of Taurus (N. A. Morozov's version), or the circle near Pisces with the man making an offering (T. N. Fomenko's version). The result revealed the circle over the back of Taurus to stand for the Sun in the primary horoscope, whereas the circle near Pisces stood for the same in the secondary horoscope of spring equinox.

Possible distribution intervals and "best points" for the Sun and the Moon in the Long Zodiac were chosen differently, depending on the interpretation option.

Step 2, qv in CHRON3, Chapter 16:7.2. Having defined the planets of the primary horoscope, in the present case including the optional choices for the Sun, the Moon and the auxiliary planet (the second Mercury), we used the Horos software to calculate all the dates when the distribution of planets over the real celestial sphere corresponded with their disposition in the Long Zodiac (according to each of the possible interpretation options).

We would require exact correspondence of planetary order in the solution and the Long Zodiacs. Solutions that failed to satisfy to this condition were rejected, qv in CHRON3, Chapter 16:7.

The result was several dozens of preliminary dates chaotically scattered across the entire interval between 500 B.C. and 1900 A.D. where we have searched for solutions, qv in CHRON3, Chapter 16:7.

The next step involved testing the dates for compliance to secondary horoscopes and planetary visibility indicators.

3.5. Secondary horoscopes in the DL zodiac

We gave a brief overview of the Long Zodiac's secondary horoscopes above, in CHRON3, Chapter 15:8. Here we shall give a more detailed account of the horoscopes' planetary compound. The symbols of the actual solstice and equinox points that mark the positions of the secondary horoscopes in an Egyptian zodiac were described meticulously enough in CHRON3, Chapter 14:2-3 and CHRON3, Chapter 15:8.

3.5.1. Autumn equinox horoscope in the DL zodiac

The autumn equinox horoscope is always located in Virgo, qv in CHRON3, Chapter 15:8. Planetary symbols of this horoscope from the Long Zodiac are as follows (see fig. 17.16).

The second third of Virgo, which is represented by the female figure that follows Virgo immediately, contains auxiliary planetary symbols from the secondary horoscope. The figure of the young woman differs from other ten-degree figures from this zodiac to a great extent (see fig. 17.16). This figure includes the planetary symbols of the secondary autumn equinox horoscope, qv in CHRON3, Chapter 15:8.1. Let us study it attentively (fig. 17.16).

Firstly, it has a leonine head. We already know this

Fig. 17.16. The second ten-degree figure of the Virgo constellation from the Long Zodiac of Dendera (DL). It follows Virgo and contains planetary symbols of the secondary autumn equinox horoscope. Fragment of a drawn copy from [1100], A. Vol. IV, Pl. 20.

to symbolise Venus in Egyptian zodiacs – so the planet referred to here is most likely to be Venus. This shouldn't surprise us, since Venus is nearly always present in secondary horoscopes because of its permanent proximity to the sun, qv in CHRON3, Chapter 15:8.

Secondly, we see a crescent over the young woman's leonine head, which means that the Moon was visible near this location on the day of the autumn equinox. The Moon may have been very close to Venus, since their respective symbols, the crescent and the leonine head, are in close conjunction.

Another possible interpretation could be that the crescent in question is a symbol of Saturn. However, in the present case we have to reject this version, since it contradicts the position of Saturn in the primary horoscope, qv in CHRON3, Chapter 15:5.1.

Furthermore, there is a solar bird over the shoulder of the same young woman. As we already pointed out, this bird makes the appearance of "flying" along the entire zodiac, marking the noteworthy places on the ecliptic by "stops", qv in CHRON3, Chapter 15:9.2.

There are no other auxiliary symbols in this segment of the Long Zodiac. In particular, there are no symbols of Mercury anywhere in the vicinity of Virgo. A small part of the zodiac between Leo and Virgo is destroyed, but, according to the rest that remained intact, the only symbol from that area is that of the new year – a woman on a stool with an infant standing on her hand, qv in CHRON3, Chapter 15:8.1.

Since we don't find Mercury here, it is most likely to have been invisible that day. Otherwise, as a planet that is never too far away from the Sun, it would have been part of the secondary horoscope.

We come up with the following interpretation of this primary zodiac as a result:

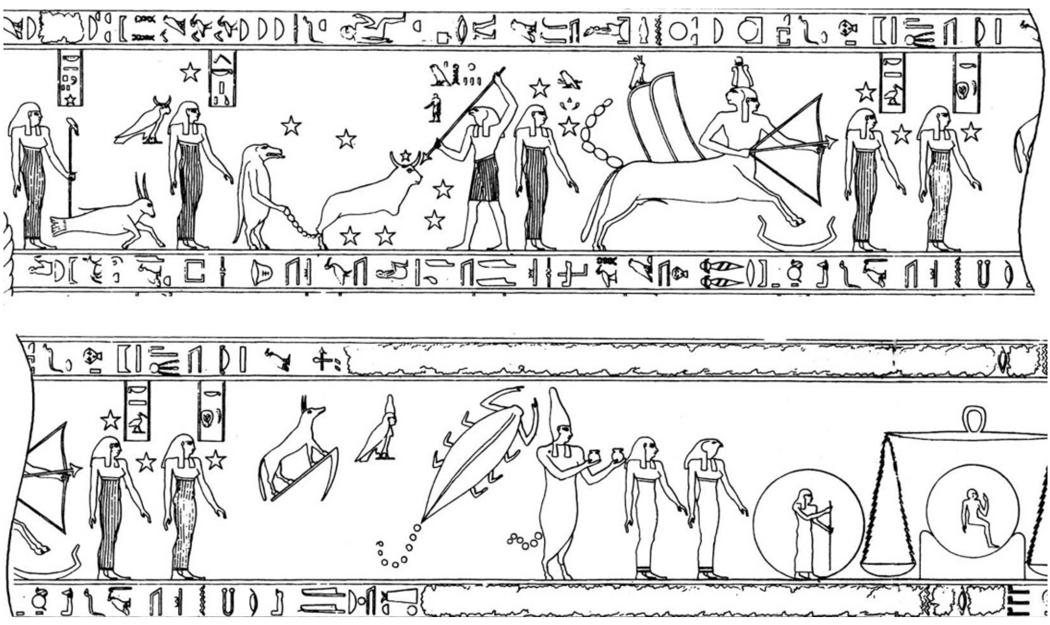


Fig. 17.17. Area of the secondary winter solstice horoscope in the Long Zodiac of Dendera (DL). Fragment of a drawn copy from [1100], A. Vol. IV, Pl. 20.

On the day of autumn equinox, one could see Venus and the Moon in Virgo, close to the Sun. Mercury is most likely to have been invisible. There were no other planets visible in or near Virgo on that day.

3.5.2. Winter solstice horoscope in the DL zodiac

This secondary horoscope from the Long Zodiac proved to be rather rich in content, qv in fig. 17.17.

The figure of Sagittarius, which is the constellation where we find the Sun on the day of winter equinox in every Egyptian zodiac, is drawn as a special "astronomical hieroglyph of winter equinox" in the Long Zodiac. See more in CHRON3, Chapter 15:8.2. As we already know, such hieroglyphs integrate the constellation figure (Sagittarius in this case) with the symbols of the Sun, Venus and Mercury. All of the above is fully manifest in the Long Zodiac, qv in fig. 17.17. However, such "astronomical hieroglyphs" are useless for the purposes of dating, since they are standard drawings which we find to be more or less similar from zodiac to zodiac. They carry no specific information that could characterise the astronomical ambience of a given year and are therefore trivial.

However, in the Long Zodiac one finds other drawings of secondary horoscope's planets. This time they provide us with valuable information that facilitates astronomical dating.

Let us first study the part of the Long Zodiac that lies to the left of the "Sagittarius and winter solstice" hieroglyph, qv in fig. 17.17. We shall disregard the symbolic scene with the slaughter of a calf, which also relates to the winter equinox point, qv in CHRON3, Chapter 15:9.5. It is followed by the figure of a young woman that symbolises the first ten degrees of Capricorn. See CHRON3, Chapter 15:2.1 above for more on the enumeration of ten-degree segments in the Long Zodiac, as well as fig. 15.28.

We see a solar bird with a crescent on its head over the shoulder of this young woman. We already recognize this sign as one that marks the points of the solar itinerary upon the ecliptic that its author considered the most important, secondary horoscopes included. Ergo, we are likely to find planetary symbols related to the secondary horoscope of winter solstice here, since we are still located in the vicinity of this secondary horoscope.

Indeed, immediately after the ten-degree figure of a young woman, at the very edge of the zodiacal strip, we see a woman with a planetary rod in her hand. She rests it right upon the figure of Capricorn, qv in fig. 17.17.

In CHRON3, Chapter 15.21 we already demonstrated that the young woman in question isn't a ten-degree symbol in the Long Zodiac; the fact that we see her hold a planetary rod clearly implies a planetary identity, and the female gender of the figure can only refer to Venus. The figure does not belong in the primary horoscope since it is complemented with a transposition symbol – the rod rests on the constellation figure of Capricorn. See more on transposition symbols in CHRON3, Chapter 15:6.

Thus, Venus was in Capricorn on the day of the winter solstice.

The solar bird that "stops" over the figure of Capricorn has horns which look like a crescent. What could they mean? The crescent-shaped horns may be a reference to the Moon in a secondary horoscope; however, in the present case the crescent may also symbolise Saturn. Bear in mind that Saturn was in Capricorn in the primary horoscope, and therefore most likely to have been in the same constellation on the winter equinox day of the same year. Saturn moves very slowly and remains in the same zodiacal constellation for several years in a row.

The implication is that Saturn may have been reflected in the secondary horoscope of winter solstice, being in Capricorn, a constellation adjacent to Sagittarius. However, this is extraneous from the astronomical point of view, since the position of Saturn in the primary horoscope defines the planet's position for the rest of the year as well. However, if Saturn is indicated in the secondary horoscope of winter solstice separately, we just have a single candidate for it – the crescent-shaped horns on the head of the solar bird. Such horns symbolize Saturn in Egyptian horoscopes, as we mentioned above in CHRON3, Chapter 15:4.2. Such horns are also an attribute of Saturn in the primary horoscope of the Long zodiac, qv in fig. 15.31.

Now let us study the other part of the Long Zodiac – one that lies to the right of Sagittarius. First we see figures of two young women – the bordering ten-degree segments of Sagittarius and Scorpio. Then we see the scene with a wolf over a scythe and the solar bird nearby. We mentioned this symbol in CHRON3, Chap-

ter 15:9.6. It accompanies the winter solstice point in both zodiacs from Dendera, but its meaning remains unknown to us.

Next we see the sign of the Scorpio constellation followed by a fantasy figure of a man with bovine legs and a cup in each hand. We couldn't gather much about its meaning, either. However, we must point out that numerous figures with similar cups in their hands accompany planets in the secondary horoscopes of the Lesser Zodiac of Esna, which we shall cover in detail below. One must therefore be very cautious – it is possible that what we see is a planetary symbol from a secondary horoscope. Indeed, after the perfectly normal figure of a young woman that marks another ten degrees of Scorpio we see another young woman, the last ten-degree figure of Scorpio bordering with Libra, qv in fig. 17.17. This one isn't quite normal – it has the head of a falcon (*ibid*). We already encountered this method of integrating a secondary horoscope's planetary symbol in the figure of a young woman that marks ten degrees of a constellation in the Long Zodiac. We see Venus marked like this in the secondary horoscope of the autumn equinox. Therefore, we must be seeing Mars here, since no other planet is represented by a falcon's head in the primary zodiac, qv in CHRON3, Chapter 15:4.7.

The implication is that Mars was in Scorpio on the day of the spring equinox – most likely, in the part of the constellation that borders with Libra. Strictly speaking, this Martian figure may also refer to the secondary horoscope of the autumn equinox, since we see it almost exactly in the middle between Virgo and Sagittarius.

The final version of the secondary winter solstice horoscope from the Long Zodiac is as follows: Venus and Saturn (possibly accompanied by the Moon) are in Capricorn, Mercury is near the Sun, which is in Sagittarius – however, Mercury's position isn't stated explicitly. Mars is in Scorpio, not far away from Libra. There were no other planets near the Sun. Should Mars prove absent, it will manifest in the same position during the autumn equinox.

3.5.3. Horoscope of spring equinox in the DL zodiac

The spring equinox point in Pisces is marked with a rectangular plaque in the Long Zodiac of Dendera. The only candidate for a secondary horoscope planet in the vicinity of Pisces is the large circle containing a man who makes an offering – and that only if the circle in question isn't a figure from the primary horoscope. There are no other possible representations of secondary horoscope planets anywhere in the neighbourhood of Pisces – all other figures are already "called for". They either stand for primary horoscope planets or ten-degree figures in their standard female representation, charged with no additional symbolic meaning.

If the circle near Pisces bears relation to the secondary horoscope, it should naturally represent the Sun, since the latter would be altogether absent from the horoscope in question otherwise. This would render the secondary horoscope of spring equinox nonexistent, since the central planet of any secondary horoscope is always the Sun, and it is always drawn in some manner.

As for the male figure making an offering inside the circle, it may stand for some secondary horoscope planet in theory. However, the figure has no characteristics of any kind that would allow us to identify it as a planet without ambiguity; the only obvious thing is the male gender of the figure, which means it can be identified as any planet at all, excepting Venus. It is possible that the planet in question is the one we find the closest to the Sun on the day of the spring equinox, one that "makes an offering" to the Sun then.

This secondary horoscope gives us no further data.

3.5.4. The summer solstice horoscope in the DL zodiac

The summer solstice horoscope that we find in the Long Zodiac of Dendera is rather noteworthy (see fig. 17.18).

The actual sign of Gemini as drawn in the Long Zodiac is an "astronomical hieroglyph" that combines the symbol of Gemini with those of Mercury and Venus – a common occurrence in Egyptian zodiacs, qv in CHRON3, Chapter 15:4.8. In other words, it comprises Gemini and a minimal horoscope of summer solstice as explained in fig. 15.67 above. The symbol itself is very remarkable and of paramount importance to the general understanding of the Egyptian zodiacs and their astronomical content. However, it is of no utility for dating, being a standardised symbol which remains the same from zodiac to zodiac.

If we are to continue to move leftwards from Gem-

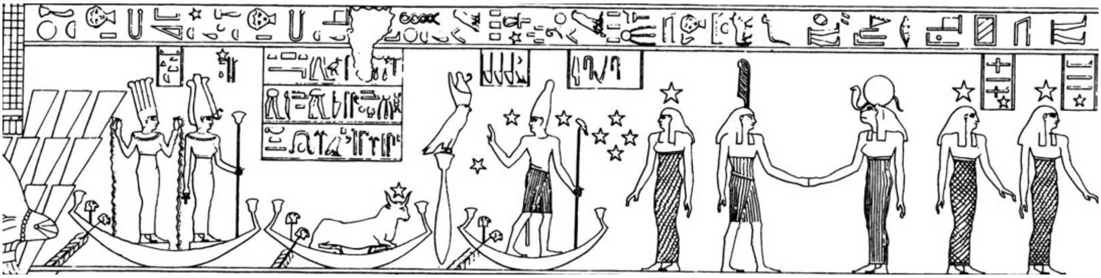


Fig. 17.18. Area of the secondary summer solstice horoscope in the Long Zodiac of Dendera (DL). Fragment of a drawn copy from [1100], A. Vol. IV, Pl. 20.

ini, our direction being opposite to that of the procession, we shall see a young woman facing backwards and standing for the first ten-degree segment of Cancer, followed by the already familiar symbols of summer solstice – the man with his hand raised into the air and a solar bird on top of a perch, qv in CHRON3, Chapter 15:8.4.

We need to be attentive here – we cannot afford to miss the fact that the ten-degree female figure in Cancer, the one that follows Gemini immediately, is facing the opposite direction, which is the only such case in the entire Long Zodiac – all other ten-degree female figures face the same direction as the rest of the procession.

The young woman is facing the opposite direction for a good reason. Had she failed to do so, the entire scene that we see to her left would have been behind her back – already in Cancer, that is. However, having made the figure face the opposite direction, the Egyptian artist also got her to face the scene on the left, placing the scene in Gemini ipso facto. Furthermore, as we shall see below, the entire row of figures that we see to the left of this young woman should be read in the direction opposite to the rest of the zodiac. In other words, a correct disposition of figures would require a reversal of their order, complete with the ten-degree figure of a young woman, so that the entire row should become superimposed over Gemini, possibly also crossing the border of Taurus. The ten-degree figure shall be facing the "correct" direction, and the figures on its left shall end up in Gemini and partially Taurus.

The above made clear, let us attentively study the row of figures, starting with the "reversed" ten-degree female figure and ending with the edge of the zodiac (see fig. 17.18). If we are to follow the zodiac from the edge and towards the young woman facing backwards – Taurus to Gemini, that is, considering the reversed order of figures in this segment, we shall first see two women standing in a boat. The one in front is holding a planetary rod, whereas the one in the back has a pitcher in each hand and pours water à la Aquarius.

The meaning of the scene is rather clear in general. The planetary rod held by the first female figure identifies it as a planet, which can only be Venus, since it is represented by a pair of female figures, qv in CHRON3, Chapter 15:4.8. The fact that both women are standing in a boat means that Venus bears no relation to the primary horoscope, having been transposed elsewhere, qv in CHRON3, Chapter 15:6. Furthermore, since we are considering the area that contains the secondary horoscope of summer solstice, this is where Venus should belong as well.

Venus had therefore either been in Taurus or close nearby on the day of summer solstice; possibly in Gemini or in Aries, near the border of Taurus. The pitchers of water in the hand of the second female in the pair that represents Venus might refer to the fact that Venus passed the constellation of Aquarius recently. Indeed, in order to arrive in Taurus, Venus first had to pass the constellations of Aquarius, Pisces and Aries, qv in fig. 16.4 above. It remains unclear why the transition of Venus through Aquarius would be emphasised here.

Let us move on. The pair of women in a boat is followed by yet another boat that carries a calf. We are already familiar with this symbol of summer solstice

as used in Egyptian zodiacs, qv in CHRON3, Chapter 15:4.8.

Next we see the perch with the solar bird on top of it – another symbol of summer solstice, qv in CHRON3, Chapter 15:4.8.

The last symbol in the row looks like a man in a boat with one hand raised high into the air, qv in fig. 17.18. This symbol is also known to us quite well – we encounter it in many Egyptian zodiacs, and it always marks the summer solstice point, qv in CHRON3, Chapter 15:4.8. It is possible that this figure represents the Sun during summer solstice, and so the figure was given a planetary rod. The boat underneath the figure prevents us from confusing it for a planetary figure from the primary horoscope, qv in CHRON3, Chapter 15:6.

We come up with the following interpretation of the summer solstice horoscope in the Long zodiac:

Venus is in Taurus or close nearby; the position of Mercury isn't specified. Or, alternatively, the "second Mercury" relates to this secondary horoscope and its location is indicated between Taurus and Gemini. We see no other planets except for Venus and Mercury, which means that they weren't visible anywhere near the sun that day.

3.6. Validation and rejection of preliminary solutions

Step 3, qv in CHRON3, Chapter 16:7.3. This step involved the verification of all the previously-obtained preliminary solutions. Namely, A. Volynkin's astronomical program by the name of Turbo-Sky was used for verifying the following:

a) Exact correlation between the real (calculated) positions of planets as they are distributed along the zodiacal constellations and the horoscope of the Long Zodiac in the chosen interpretation. See CHRON3, Chapter 16:7 in re the necessity of such verification.

b) Compliance to visibility indicators of Venus and Mercury: Venus must be visible, whereas Mercury is invisible in the position between Taurus and Aries and visible between Taurus and Gemini. These positions must be close to each other temporally (which is possible, due to the fast motion of Mercury).

Planet luminosity at the specified moment and the depth of the Sun's submersion below the horizon for the moment the planet would rise or set were accounted for, qv in CHRON3, Chapter 16:7.

c) Correspondence to secondary horoscopes as described in the previous section (see also CHRON3, Chapter 15:5-8) and other auxiliary astronomical representations, qv in CHRON3, Chapter 15:9).

One of the necessary requirements was that the symbolic description of every secondary horoscope contained in the Long Zodiac should correspond to the real celestial sphere for the year of the solution under study. We would consider different possibilities for the beginning of a year as well. A general description of the procedure we used for verifying the solutions with the aid of secondary horoscopes and auxiliary symbols can be found in CHRON3, Chapter 16:7.

The resultant exhaustive solution for the Long Zodiac was unique:

22-26 April 1168 A.D.

The discrepancy between this date and the early A.D. epoch when the Egyptologists consider the Temple of Dendera to have been built is greater than a millennium ([1062]). Below we shall see that the second zodiac found in the same temple of Dendera contains a date that is very close to the present one – 1185 A.D. The two dates are separated by a mere 17 years.

There is yet another date that we deciphered from Egyptian zodiacs which belongs to the same epoch of the second half of the XII century. We are referring to the OU zodiac found in one of the royal tombs in the "Valley of the Kings". Its dating is described in the next chapter. The date it contains is 1182 A.D. The dates from the zodiacs of Dendera pertain to the same epoch.

We shall comment on the real meaning of these dates below. For the meantime, let us simply reiterate that all the dates ideally correspond to our general reconstruction of history based upon the New Chronology ([METH1], [METH2], [METH3] and [REC]). According to the New Chronology, the history of Ancient Egypt, likewise other "ancient civilizations" can really be dated to the X-XVI century A.D.

This is where we also find the dates ciphered in the Egyptian zodiacs.

3.7. The exhaustive solution of the Long Zodiac: 22-26 April 1168 A.D.

And so, we have considered a great many possible options of identifying the primary horoscope's planets in the Long Zodiac of Dendera. Bear in mind that the ambiguity that affected the decipherment of the primary horoscope only concerned the figures of the Sun and the Moon.

However, we have found an exhaustive solution for just a single decipherment option applicable to the primary horoscope. It is as follows:

DATA FOR THE HOROS SOFTWARE

Zodiac: Long Zodiac of Dendera (DL).
Interpretation option: The Sun as the circle in Taurus, Moon in Libra.
Interpretation option code: DL2.
Planetary positions of the primary horoscope:
The Sun is the circle on the back of the Taurus figure. Possible range: between the middle of Aries and the middle of Gemini; best point in the middle of Taurus.
The Moon is either the circle in Libra, or the one between Libra and Scorpio. Possible range: Libra or Scorpio; best point in the middle of Libra.
Saturn in either Aquarius or Capricorn. Possible range: Aquarius or Capricorn; best point at the cusp of Aquarius and Capricorn.
Jupiter in Pisces or Aries. Possible range: Pisces or Aries; best point at the cusp of Pisces and Aries.
Mars in either Pisces or Aquarius. Possible range: Pisces or Aquarius, best point in the middle of Aquarius.
Venus in either Aries or Taurus. Possible range: Aries or Taurus, best point at the first third of Aries (close to the middle).
Mercury in either Aries, Taurus or Gemini. Possible range: Aries, Taurus or Gemini. Best point in the middle of Taurus (averaging both options).
All possible range boundaries can be crossed by a distance of 5 arc degrees or less.
The order of planet on the ecliptic, beginning from the autumn equinox point, arranged by longitude (counting from the head of the zodiacal procession):
Moon Saturn Mars Jupiter Venus Mercury <–> Sun.
Mercury and the Sun are interchangeable, since we see Mercury on either side of the Sun.

DATA

	Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
# FROM: ——— #							
	0.5	6.0	9.0	11.0	10.0	.0	.0
# TO: ——— #							
	2.5	8.0	11.0	1.0	12.0	2.0	3.0
# BEST POINTS: ——— #							
	1.5	6.5	10.0	12.0	10.5	.3	1.5

END OF DATA

NB: Planetary positions are given on the planetary scale:

<0> Aries <1> Taur <2> Gemini <3> Cancer <4> Leo <5> Virgo <6> Lib <7> Scorp <8> Sagittarius <9> Capricorn <10> Aquarius <11> Pisces <12=0>

In this interpretation option the Sun is the circle on the back of the Taurus figure, whereas the Moon is the circle in Libra. The narrow crescent in the bottom of the solar circle on the back of Taurus may refer to a new moon in Taurus. The exhaustive solution declared the new moon in Taurus to have been related to the Passover Moon, being the birth of the latter. This may be why it enjoys special attention in the zodiac.

As for the two other circles in the Long Zodiac – according to the full solution, the circle near Libra refers to the Easter full moon, whereas the circle near Pisces stands for the Sun in the secondary horoscope of spring equinox. See more details below.

We found an exhaustive solution for this interpretation version, which also proved unique – 22-26 April 1168 A.D. The best correlation between the solution and the zodiac is reached on 23 April 1168 A.D., on a full moon. This must be the date ciphered in the Long Zodiac of Dendera. However, strictly speaking, any date from the interval between the 22 and 26 April fits the solution perfectly.

The average distance between the planets in this solution and their respective "best points" equalled a mere 12 degrees for 23 April 1168 A.D., which is about 1/3 of a zodiacal constellation's average length on the ecliptic. Let us remind the reader that the "resolution" of the Egyptian zodiacs cannot exceed half of a zodiacal constellation, which roughly equals 15 de-

grees. Therefore, 12 degrees provides us with perfect concurrence for the astronomical solution, qv in CHRON3, Chapter 16:12.

Below we cite calculated planetary positions for the 22, 23 and 26 April 1168 A.D. Apart from the date in a Julian calendar (year/month/day), we also give the Julian day for this date, which is the actual value used in astronomical calculations ([393], page 316). See CHRON3, Chapter 16:4.

Planetary positions are given in degrees on the ecliptic J2000 (first line) and the "constellation scale" (second line). Apart from that, in the third line one finds the name of the constellation that the planet was located in. See more details in CHRON3, Chapter 16:4.

THE EXHAUSTIVE SOLUTION OF THE LONG ZODIAC OF DENDERA (PRIMARY HOROSCOPE)

Julian day (JD) = 2147782.00
Year/month/day = 1168/4/22

Moon	Saturn	Mars	Jupiter	Venus	Mercury	Sun
212.7	327.0	330.8	361.2	39.3	43.2	50.4
5.93	9.91	10.07	11.37	.51	.67	.95
Vir/Lib	Cap/Aqua	Aqua/Cap	Pisces	Aries	Aries	Ari/Tau

Average deviation from "best points" equals 13.7 degrees.

Julian day (JD) = 2147783.00 Full Moon in Libra
Year/month/day = 1168/4/23

Moon	Saturn	Mars	Jupiter	Venus	Mercury	Sun
225.1	327.0	331.5	361.4	38.8	42.7	51.4
6.45	9.91	10.12	11.37	.49	.65	1.01
Libra	Cap/Aqua	Aquarius	Pisces	Aries	Aries	Tau/Ari

Average deviation from "best points" equals 11.7 degrees (local minimum).

Julian day (JD) = 2147786.00
Year/month/day = 1168/4/26

Moon	Saturn	Mars	Jupiter	Venus	Mercury	Sun
261.4	327.0	333.6	362.0	37.5	41.5	54.2
7.83	9.91	10.24	11.39	.44	.60	1.07
Scorpio	Cap/Aqua	Aquarius	Pisces	Aries	Aries	Taurus

Average deviation from "best points" equals 15.8 degrees.

3.8. Verification table for the exhaustive solution of the Long Zodiac

Let us cite the verification results of the above-mentioned exhaustive solution. The verification table can be seen in fig 17.19.

We must remind the reader that the verification table demonstrates the degree of correspondence between one astronomical solution and another, also citing the original data present in the Egyptian zodiac. A complete or exhaustive solution is one where we find a "+" in every column of the verification table, which testifies to ideal correspondence with the Egyptian zodiac with all criteria satisfied, qv in CHRON3, Chapter 16:14. The following abbreviations are used on the reference sheet:

S. S. – the submersion of the Sun under the local horizon in arc degrees in fig. 17.19. For instance, S. S. = 10 means that the Sun set by 10 degrees.

M – magnitude or current luminosity of a planet according to the photometric scale as used in astronomy. For instance, M = –3.2 means that the luminosity of the planet in question equalled –3.2. Planetary luminosity fluctuates considerably over the course of time, qv in CHRON3, Chapter 16:7.3.

The fractional value in parentheses between 0 and 12 is the calculated position of the planet on the "planetary scale", qv in CHRON3, Chapter 16:10. For instance, 2.5 stands for the middle of Gemini or a point with the longitude of 70 degrees on the ecliptic J2000.

The Greek letter delta (∅) refers to the celestial distance in arc degrees in fig. 17.19.

Let us review the columns of the verification table as seen in fig. 17.19.

The first column stands for the visibility of Mercury. In the days included in our solution Mercury definitely wasn't seen in either Cairo or Luxor. The verification table contains data related to the submersion of the Sun as observed from Cairo. In Luxor this submersion value may be greater by a factor of one degree at best, which won't affect the visibility of Mercury in any way at all. Indeed,

On 22 April 1168, which is the first day covered by the solution, the submersion of the Sun equalled a mere 4 degrees in Cairo when Mercury rose (and 5 degrees maximum in Luxor). The luminosity of Mercury had been very low, namely, +3.3. These condi-

tions make the visibility of Mercury an impossibility. On 26 April 1168, which is the last day covered by the solution, the submersion of sun equalled 6 degrees in Cairo and 7 degrees maximum in Luxor. The luminosity of Mercury remained very low equalling +2.1. These conditions also put the visibility of Mercury out of the question.

We are thus informed of Mercury being invisible on the days covered by the solution. In this case it should be drawn in the zodiac as a two-faced figure between Aries and Taurus. Bear in mind that this particular drawing of Mercury in the Long Zodiac has got no star over its head and is drawn in the invisible position, qv above.

Indeed, Mercury in our solution is located in the very middle of Aries. This corresponds to its position in the Long Zodiac perfectly.

Thus, the second Mercury should either pertain to the secondary horoscope of summer solstice, which is the area where we find it, or come from a separate auxiliary scene. We do find such scenes in the Long Zodiac – Mars approaching Saturn on a goose etc, qv below. At any rate, in our solution the second Mercury cannot be part of the primary horoscope together with the other figure, since, according to our calculations, Mercury remained in Aries on the 22-26 April 1168. However, the second Mercury is drawn in Taurus – on the other side of the Sun, in other words.

The second Mercury should therefore manifest in other columns of the verification table. We put a "plus" sign in the first column, since our solution corresponds to the Long Zodiac precisely insofar as the visibility of Mercury is concerned.

The second column refers to the visibility of Venus. The figure of Venus has a star over its head in the Long Zodiac, which informs us of its visibility. Indeed, Venus was visible perfectly well in our solution, remaining in its morning visibility. The conditions of its observations have been as follows in Cairo (and better still in Luxor):

On 22 April 1168, which was the first day of the solution, the submersion of the Sun equalled 10 degrees when Venus rose in Cairo. The luminosity of Venus had been high, –2.8. Thus, we know a priori that Venus was visible very well throughout this period. On 26 April 1168, which is the last day of the solution, the conditions for its observations were even better in Cairo – namely, the Sun would set by 12 degrees when Venus rose, and the luminosity of the latter equalled –3.7, which is even higher than on the first day.

Therefore, Venus was visible very well in the morning every day beginning with 22 and ending with 26 April 1168, and so we put another plus sign in the second column.

We must emphasise that in our solution Venus was in the middle of Aries, near Mercury; it was closer to Pisces and further away from Taurus than Mercury. This is exactly how Venus and Mercury are positioned in the Long Zodiac.

The third column relates to the secondary horoscope of autumn equinox.

The September year that spans our solution began in September 1167 A.D. and ended in August 1168. The autumn equinox day took place in the beginning of the year, or September 1167 A.D.

It has to be said that we tried other versions for the beginning of the year for which the autumn equinox that corresponds to our solution took place in 1168 and not 1167 A.D. However, there were no secondary horoscope correspondences in this case. This applies to every other Egyptian zodiac as well, excepting the ones from Athribis, which means that for the absolute majority of Egyptian zodiacs the year began in September. See more on this in CHRON3, Chapter 15:12.

We must point out that a precise estimation of equinox and solstice dates had been a serious problem for the ancient astronomy. Therefore, it is possible that the authors of the Egyptian zodiacs only knew these days approximately, give or take a few days. In CHRON6, Chapter 19 we demonstrate that the error in estimating the equinox date equalled 6 days in some XIV century books.

Therefore, in our study of secondary horoscopes in Egyptian zodiacs we shall account for possible errors within the range of 6 days that the precise date of the respective solstice or equinox falls into. We must point out that although planetary positions are usually indicated very approximately in secondary horoscopes, the 6-day fluctuation might only be important in case of the Moon and Mercury. It is of little importance inasmuch as other planets are concerned.

Autumn equinox fell on the 11-12 September in 1167, qv in Annex 5. Adding six days from each side,

The Long Zodiac of Dendera (DL). Verification table for the solution of 22-26 April 1168 A. D.

Visibility of Mercury	Visibility of Venus	Autumn equinox	Winter solstice	Spring equinox	Summer solstice	The Passover Full Moon	Additional scenes	*Notes*
		S E P	T E M B	E R	Y E A R			
Mercury rising in Cairo: 22.04.1168 S. S. = 4°, M = +3.3. *Invisible.*	Venus rising in Cairo: 22.04.1168 S. S. = 10°, M = -2.8. *Visible.*	5-18 Sept. 1167 A. D. Sun in Virgo.	5-18 Dec. 1168 A. D. Sun in Sagittarius (8.4).	7-20 March 1168 A. D. Sun in Pisces (11.6).	6-18 June 1168 A. D. Sun in Gemini (2.4).	The Passover Full Moon in Libra. 26 March 1168. The next full Moon is also in Libra (6.5). 23 March, the primary horoscope date. ⊕	16.04.1168. Mars meeting Saturn in Capricorn. Distance = 40'. Mars approaches Saturn on a goose, preceding the primary horoscope's date by 6 days. ⊕	Interpretation code DL2. The first vernal (Passover) full Moon according to Gaussian formulae: 26 March 1168 A. D. The Passover full Moon according to the Paschalia: 27 March 1168. The Christian Easter according to the Paschalia: 31 March 1168.
26.04.1168. S. S. = 6°, M = +2.1. *Invisible.*	26.04.1168 S. S. = 12°, M = -3.7. *Visible.*	Venus in Virgo (5.9). *Shown.* ⊕	Mercury in Sagittarius (8.9). Shown. ⊕	Jupiter in Pisces is visible in Cairo in the morning. S. S. = 15°. M = -1.5. *Shown.* ⊕	Venus in Taurus (1.1). Shown separately. ⊕			
Corollary: Mercury is the two-faced figure between Aries and Taurus. ⊕	*Corollary:* Venus was visible quite well. ⊕	The new Moon is born near Venus (distance of 30'). 17.09.1167. Shown.	Venus in Capricorn (9.7). Shown. ⊕	Mercury and Venus are in vespertine visibility, close to their positions in the primary horoscope => not shown.	Mercury 6.06.1168 is in Taurus (matutinal visibility in Cairo): S. S. = 8°, M = -0.0. Shown separately. ⊕ The "second Mercury".			
		Mercury and Mars are too close to the Sun => *invisible* and not shown. ⊕	The new Moon is born in Capricorn. 15.12.1167 OR Saturn (M = +1.0) in Capricorn. *Shown.* ⊕	The morning star making an offering in the solar circle is Jupiter. ⊕	Jupiter and Mars in Pisces, Saturn in Capricorn. Not shown. ⊕			
		Saturn and Jupiter in Capricorn. *Not shown.* ⊕	Mars (M = +1.6) on the cusp of Scorpio and Libra. *Shown.* ⊕		The new Moon is born in Cancer. 9.06.1168. ⊕			
			Jupiter in Aquarius. *Not shown.* ⊕					$\varnothing_{ref}$ = 12° + + + + + + + +

Fig. 17.19. The verification table for the exhaustive solution of the Long Zodiac (DL) – 22-26 April 1168 A. D. Abbreviations used: S. S. = the solar submersion rate in arc degrees (see CHRON3, Chapter 16:7, Step 3-B); M = planetary luminosity; fraction value between 0 and 12 in parentheses = calculated position of the planet on the "constellation scale", qv in CHRON3, Chapter 16:10. Bottom right – the result of comparison with the zodiac, as well as the average distance between the planets and their best points. See CHRON3, Chapter 16:11 and 16:14.

we shall come up with the interval of 5-18 September 1167.

Let us cite planetary positions for the three-day period between 13 and 15 September 1167 A.D. The length of the interval is chosen deliberately, in order to make the motion of the Moon visible.

Julian day (JD) = 2147560.00
Year/month/day = 1167/9/13

Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
188.1	168.4	309.3	324.4	178.9	209.3	179.6 (longitude J2000)
5.33	4.80	9.28	9.82	5.10	5.85	5.12 (constellation scale)

Julian day (JD) = 2147561.00
Year/month/day = 1167/9/14

Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
189.1	181.2	309.2	324.3	179.5	210.5	178.9 (longitude J2000)
5.36	5.16	9.27	9.81	5.12	5.88	5.11 (constellation scale)

Julian day (JD) = 2147562.00
Year/month/day = 1167/9/15

Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
190.1	193.8	309.2	324.3	180.2	211.8	178.4 (longitude J2000)
5.38	5.47	9.27	9.81	5.14	5.91	5.09 (constellation scale)

Turbo-Sky calculations demonstrate that the new moon falls on 17 September 1167 – the moon was near Venus, at the distance of a mere 30 minutes. It became visible in Cairo in the evening of 17 Septem-

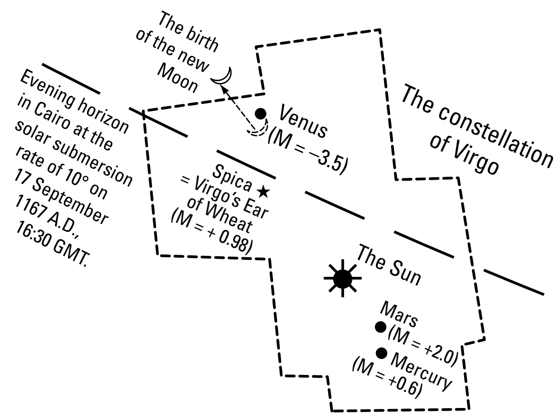


Fig. 17.20. Celestial sphere in the vicinity of the autumn equinox point on 17 September 1167 A. D. Calculated in Turbo-Sky. We see the evening horizon in Cairo at the solar submersion rate of 10 degrees. Venus was very bright that day (M = –3.5) and could be seen at dusk, as well as the crescent of the new Moon, which had made its first appearance right next to it. There were no other visible planets anywhere near. The drawing is approximated.

ber when it moved away from Venus a little, but still remained rather close to the planet, qv in fig. 17.20.

On the day of the autumn equinox in 1167 the sky in Cairo was looking as follows. Venus was very bright and could be seen shining at dusk, with no other planets anywhere near. On 17 September the crescent of the new moon appeared near Venus. No planets were visible at dawn, since both Mars and Mercury were so close to the Sun from the side of morning visibility that they became completely lost in the light of its rays, qv in fig. 17.20.

This is in perfect concurrence with the secondary horoscope of the autumn equinox from the Long Zodiac. Let us remind the reader of what this horoscope looked like (see CHRON3, Chapter 6:3.4.1 above):

On the day of autumn equinox one could see Venus and the Moon, as well as the nearby Sun in Virgo. Mercury is most likely to have been invisible. One could see no other planets either in Virgo or anywhere near.

The third column also gets a plus sign as a result.

The fourth column refers to the secondary horoscope of winter solstice.

The winter solstice that corresponds to our Sep-

tember year solution falls on December 1167 – namely, 11-12 December, qv in Annex 5. Adding 6 days to either side we shall come up with the interval between 5 and 18 December 1167, which we shall be considering as the "winter solstice days". Let us cite the planetary position for two days falling within this range – 14-15 December 1167 A.D. A two-day interval was chosen for better representation of lunar motion.

Julian day (JD) = 2147652.00
Year/month/day = 1167/12/14

Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
280.1	292.8	314.0	331.8	239.8	321.9	297.9 (longitude J2000)
8.41	8.73	9.44	10.13	7.11	9.72	8.90 (constellation scale)

Julian day (JD) = 2147653.00
Year/month/day = 1167/12/15

Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
281.8	304.2	314.1	332.0	240.5	323.0	298.0 (longitude J2000)
8.44	9.09	9.45	10.14	7.13	9.77	8.90 (constellation scale)

The celestial sphere as seen in Cairo at dusk and at dawn, which implies proximity to the Sun, is shown in fig. 17.21 (calculated with the aid of TurboSky). The morning and evening horizon of Cairo for 15 December 1167 A.D. with the sun submersed by 10 degrees is highlighted in the picture. One can see that the exceptionally bright Venus (M = –4.1) could be observed in Capricorn at dusk, as well as the relatively bright Saturn (M = +1.6). Right at dawn one could also see Mercury in Sagittarius – also bright (M = +0.4). On 15 December the crescent of a new Moon manifested in Capricorn. One could see no other planets at dusk. The only planet visible at dawn was Mars on the cusp of Scorpio and Libra – quire bright that day (M = +1.6) and looking rather spectacular, being at a sufficient distance from the Sun.

This corresponds perfectly to the secondary horoscope of winter solstice from the Long Zodiac. Let us remind the reader of the horoscope in question:

Venus and Saturn are in Capricorn, possibly accompanied by the Moon. Mercury is near the Sun, which is in Sagittarius; however, its position isn't stated explicitly. Mars is in Scorpio, near Libra. There were no other planets near the Sun.

Therefore, we should put a plus sign into this column of the verification table as well.

The fifth column relates to the secondary horoscope of spring equinox.

Spring equinox fell on 13 March that year, very close to the days of the actual solution, qv in Annex 5. Extending the interval by six days from both sides, we shall come up with the interval of 7-20 March 1168 for the astronomical observation that this secondary horoscope must reflect.

Let us cite the planetary disposition for 12 March 1168 A.D. It was a spring equinox accompanied by a new moon.

Julian day (JD) = 2147741.00
Year/month/day = 1168/3/12

Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
370.4	383.6	324.1	352.3	301.9	48.9	380.8 (longitude J2000)
11.60	11.93	9.80	11.14	9.01	.90	11.86 (constellation scale)

The celestial sphere in Cairo was looking as follows that day. The only planet seen at dawn was Jupiter, whose luminosity had almost been maximal (M = –1.5) – in Pisces, the same constellation as the Sun. Jupiter rose when the Sun was set by 15 degrees, and was very conspicuous. There were no other planets nearby.

Venus was visible at dusk (M = –4.9), likewise Mercury (M = –0.1). The luminosity of both planets was close to maximal. Venus had been in Aries, and Mercury in Pisces, in conjunction with the Sun. Mer-

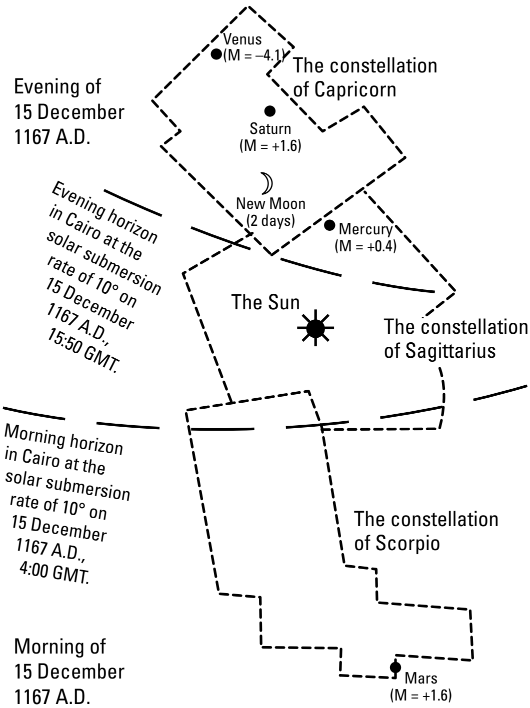


Fig. 17.21. Celestial sphere in the vicinity of the winter solstice point on 17 September 1167 A. D. Calculated in TurboSky. We see the morning and evening horizon in Cairo at the solar submersion rate of 10 degrees. Venus was exceptionally bright at sunset (M = –4.1), and Saturn was rather bright as well (M = +1.6). Both planets were in Capricorn. On 15 the new Moon's crescent appeared nearby. There were no other planets in this area. Mars was the only planet visible at dawn, on the cusp of Scorpio and Libra. Mars had been sufficiently bright (M = +1.6), and visible very well. The drawing is approximated.

cury set in Cairo when the Sun had submersed by 11 degrees, which made the planet perfectly visible at dusk. The distance between Venus and the Sun was approaching its maximum – circa 40 degrees. On the evening of 13 March the crescent of the new Moon appeared at the cusp of Pisces and Aries.

However, the secondary horoscope of the spring equinox from the Long Zodiac contains nothing but the solar circle with a male figure inside it. This is a general trend characteristic for every single Egyptian zodiac known to us – their secondary horoscope of spring equinox is empty as a rule. In the zodiacs of Dendera it is all but empty – we only see the Sun drawn explicitly, and no other objects. Mark the fact that in both zodiacs from Dendera the solar circle from this particular secondary horoscope contains a human figure that makes an offering. It must be standing for the brightest planet that made a "sacrifice" to the Sun on that day, qv in CHRON3, Chapter 17:4.5.3 (in re the Round Zodiac).

In the Long Zodiac this solar circle is very close to the figure of Jupiter in the primary horoscopes. They almost touch each other. Therefore, the planet that makes the "sacrifice" must be Jupiter as closest to the Sun in its evening visibility. Jupiter and Mercury are "male" planets and therefore correspond to the drawing from the Long Zodiac perfectly well. The offering is made by a male figure; the only planet that couldn't serve in this quality is Venus, but it couldn't be closest to the Sun since it was reaching the point of maximal elongation.

Thus, we see perfect correlation with the Long Zodiac here as well, and put another plus sign in the fifth column.

Sixth column – secondary horoscope of summer solstice.

Summer solstice would normally fall on 12 June in that epoch, qv in Annex 5. Adding 6 days on each side we come up with the interval between 6 and 18 June 1168, which includes the date of summer solstice. The discrepancy of several days between 6 and 18 June only affects the Moon in the present case. Let us provide an example of planetary dislocation on the ecliptic for 14 June 1168 A.D.:

Julian day (JD) = 2147835.00
Year/month/day = 1168/6/14

Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
101.1	194.0	327.1	369.0	366.1	55.9	99.5 (longitude J2000)
2.40	5.47	9.91	11.56	11.49	1.11	2.34 (constellation scale)

The disposition of planets that are close to the Sun on the celestial sphere as observed from Cairo for

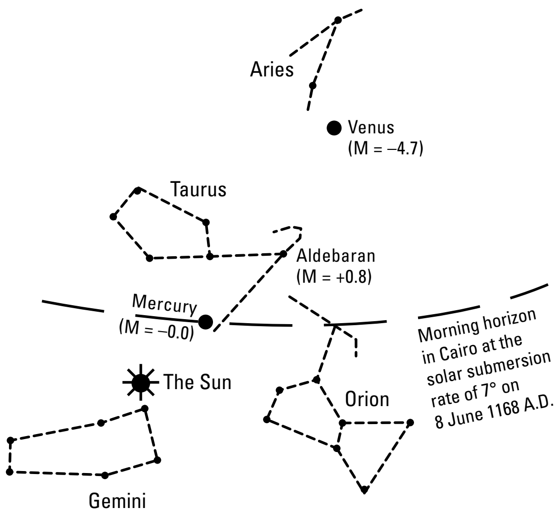


Fig. 17.22. Celestial sphere in the vicinity of the summer solstice point on 8 June 1168 A. D. Calculated in Turbo-Sky. Venus was exceptionally bright (M = –4.7) and therefore visible well at dawn. It had been at the cusp of Taurus and Aries. It is also possible that Mercury was visible in Taurus (M = –0.0). There were no other planets visible on those days, either at dusk or at dawn. All of them had been at a considerable distance – Jupiter and Mars in Pisces, and Saturn in Capricorn. The new Moon was born in Cancer on 9 June, in vespertine visibility. The drawing is approximated.

several days earlier (8 June 1168) is given in fig. 17.22 (drawing made with the aid of the Turbo-Sky software). We see the part of the celestial sphere that one finds in the vicinity of the summer solstice point, as well as the morning horizon of Cairo for 8 June 1168 A.D., with the Sun set by 7 degrees. At dawn one could see an exceptionally bright Venus at the cusp of Taurus and Aries during all of these days; its luminosity was approaching its maximum (M = –4.7).

On 8 June Mercury was very bright, and also could have been visible in Taurus (M = –0.0). Then it disappeared in the light of the Sun. One could see no other planets except for the Moon on any of these days anywhere near the Sun – either in their morning or evening visibility. They were far away – Jupiter and Mars in Pisces and Saturn in Capricorn. The new Moon was born in Cancer on 9 June 1168, and could be seen in the evening.

Let us now recollect the secondary horoscope of summer solstice from the Long Zodiac, qv in CHRON3, Chapter 17:3.5.4 above:

Venus is in Taurus or close nearby; the position of Mercury isn't specified. Or, alternatively, the "second Mercury" relates to this secondary horoscope and its location is indicated between Taurus and Gemini. We see no other planets except for Venus and Mercury, which means that they weren't visible anywhere near the sun that day.

Everything fits perfectly. The "second Mercury" wasn't involved in the primary horoscope, and must therefore relate to the secondary horoscope of summer solstice, which is the area where we find it.

Bear in mind that in the Long Zodiac Venus as drawn in this secondary horoscope (two women in a boat near the edge of the zodiac) is at a great distance from Gemini, whereas the "second Mercury" is much closer to this constellation. This corresponds well with our solution where Venus was far enough from the Sun – on the other side of Taurus, whereas Mercury had remained close to the Sun all the time, on the contrary, qv in fig. 17.22. Apart from that, the position of the "second Mercury" in the Long Zodiac (between Taurus and Gemini, closer to Taurus) ideally corresponds to its position on the celestial sphere for 8 June 1168 (see fig. 17.22).

The only objection that might arise could be directed against the fact that one doesn't see the new Moon in this secondary horoscope, although it had been born in Cancer, near Gemini, on 9 June 1168 – right at summer solstice. Strictly speaking, there is no contradiction here, since, as we have witnessed, we don't always find the Moon in secondary horoscopes of the Egyptian zodiacs. Nevertheless, we do find the Moon in another secondary horoscope of the Long Zodiac. This implies another reason for not drawing it in the zodiac. Indeed, a closer study of the Long Zodiac demonstrates that the area of Cancer where we should find the Moon isn't drawn at all. In CHRON3, Chapter 17:3.5.4 we already mentioned the fact that the author of the Long Zodiac had used a most amazing method to make the area of Cancer disappear from the zodiac – that of the "extended ten-degree figure". The actual constellation was shifted downwards, towards the knees of "the goddess Nuit". We know no real reason for this; however, the result is that all we see in Gemini is the morning visibility area be-

tween Gemini and Aries where there were no other planets but Venus and Mercury, which are indeed present in the secondary horoscope of Summer Solstice from the Long Zodiac.

Therefore, the correlation between the solution and the Long Zodiac is also very good. We put yet another plus sign in the sixth column of the verification table.

This exhausts all of the secondary horoscopes found in the Long Zodiac. We're left with the auxiliary scenes – the Passover full moon and Mars on a goose near Saturn, qv in CHRON3, Chapter 15:9.

The seventh column represents the Passover full moon. We already mentioned the fact that the first vernal full moon (or the Passover full moon, qv in CHRON3, Chapter 15:9.1) would be drawn in many Egyptian zodiacs, but not all of them. This shouldn't surprise us, since the "ancient Egypt" had been a Christian country, according to the plentiful evidence that survived the "purge" ([IMP]). We shall come back to this issue in Volumes 5 and 7 of "Chronology".

The first vernal full moon fell on 26 March in 1168. We calculated the date by the Gaussian formulae ([393]), also utilizing the Turbo-Sky software. Calculations demonstrate that the full Moon had been in Libra.

However, Libra is the constellation where we find the last circle in the Long Zodiac that we haven't accounted for as to yet. It is on the left of Libra, very close to the actual constellation figure. Inside the circle we see the drawing of a woman with a long stick, or staff, held in both hands. The symbol fits the concept of the Passover full moon perfectly well. Let us remind the reader that the Passover ritual food was supposed to be ingested standing up and holding a staff. Thus, we see the Passover full moon represented in the Long Zodiac of Dendera in perfect correspondence with the Old Testament tradition as described in the Pentateuch. We must point out that in the zodiacs of Esna whose dates postdate those of the Dendera zodiacs by 200 years, the Passover full moon is drawn more in line with the New Testament tradition, qv in CHRON3, Chapter 15:9.1.

The conclusion is that the circle near Libra in the Long Zodiac stands for the Passover full moon that fell on 26 March 1168. It has to be noted that the corresponding new moon was born in Taurus on 12 March 1168 (as calculated with the Turbo-Sky software). This full moon also appears to be represented in the Long Zodiac – mark the narrow crescent added to the solar circle in the primary horoscope. It is in Taurus – right where the Passover full moon was born, and must stand for the Passover new moon.

We must therefore put another plus sign into the seventh column of the verification table.

The eighth column refers to the additional scenes in the Long Zodiac.

The only auxiliary scene that we haven't considered as to yet is one with Mars standing on a goose to the left of Saturn in primary horoscope. It is as though Mars were approaching Saturn riding a goose, which must stand for Saturn and Mars being in conjunction.

This scene bears no valuable additional information, since the conjunction of Saturn and Mars in this part of the ecliptic is directly implied by the primary horoscope. We must nevertheless point out that in our solution this conjunction is manifest particularly well; indeed, the distance between Saturn and Mars during their conjunction in 1168 equalled a mere 40 arc minutes (Turbo-Sky). Calculations demonstrate that the conjunction took place on 16 April 1168 A.D. in Capricorn. In other words, in 1168 Mars and Saturn approached each other very closely, 6 days before the date of the primary horoscope. This must be the reason why their "meeting" is drawn in the Long Zodiac to complement the primary horoscope.

We have thus covered all eight columns of the verification table compiled for the 1168 solution for the Long Zodiac of Dendera. We see plus signs in every column, qv in fig. 17.19. This solution of the Long Zodiac is therefore exhaustive. We have found no more exhaustive solutions for any other interpretation of the Long Zodiac's primary horoscope.

COROLLARY:

The Long Zodiac of Dendera was compiled for the date of 22-26 April 1168 A.D.

4. THE DECIPHERMENT OF THE DATE FROM THE ROUND ZODIAC OF DENDERA (DR)

Let us now consider the date ciphered in the other zodiac from Dendera – the Round one, which was discovered in the same Egyptian temple as the Long Zodiac.

Fig. 17.23. The Round Zodiac of Dendera (DR). Drawn copy of the central part, apparently made in accordance with a modern photograph of the original. Taken from [1062], pages 9 and 71.

4.1. Copies of the Round Zodiac from Dendera

Above, in Chapter 12 of CHRON3, we already cited several drawings of the Round Zodiac of Dendera – those taken from the Napoleonic album on Egypt ([1100]) as well as some others, from a modern publication ([1062], see figs. 12.4 – 12.10 in CHRON3, Chapter 12. However, in the present case it isn't a drawn copy of the entire bas-relief that we need, but rather one of its central part, which is where we find the planets and the zodiacal constellations. Such a copy can be seen in fig. 17.23, which we suggest to the readers for reference.

The drawn copy in fig. 17.23 is taken from [1062]. We also had detailed photographs of the Round Zodiac at our disposal, which Professor Y. V. Tatarinov from the MSU had taken in the Louvre at our request. A comparison of these photographs with fig. 17.23 demonstrates that the drawn copy in question is very precise and accounts for every single detail of the figures' mutual disposition, which, as we shall see, is very important for the correct decipherment of the Round Zodiac.

In fig. 17.24 one sees a photograph of a fragment of the Round Zodiac.

As above, we shall provide the readers with a blow-by-blow account of our dating method as applied to the Round Zodiac, qv in CHRON3, Chapter 16:7.

Fig. 17.24. Modern photograph of a part of the Round Zodiac from the temple in Dendera. The original of the zodiac was taken away from Egypt to Europe during Napoleon's expedition, and is kept in the Louvre nowadays. What one sees in the temple is a mere copy. Taken from [370], page 165.

4.2. The coloured version of the Round Zodiac

Step 1, qv in CHRON3, Chapter 16:7.1. The initial interpretation of the primary horoscope and the compilation of the Round Zodiac's coloured copy.

The tables of collected Egyptian astronomical symbols, qv in CHRON3, Chapter 15, make the figures of every constellation and almost every planet from the primary horoscope in the Round Zodiac easy to identify, qv in CHRON3, Chapter 15:1, and CHRON3, Chapter 15:4. Likewise in the Long Zodiac, there is some ambiguity here concerning the Sun and the Moon, and it leads us to different identification options. Other planets of the primary horoscope are identified unambiguously for the most part.

As a result, the coloured Round Zodiac was compiled, as seen in fig. C5.

Below, in our discussion of the Round Zodiac, we shall assume that the readers always have the "coloured zodiac" as well as the original copy (fig. 17.23) and the photographs in fig. 17.24 at their disposal to use for reference whenever they need to.

4.3. Constellation figures in the DR zodiac

Constellation figures from the Round Zodiac are highlighted red in fig. C5. Their symbols are always the same as we find in the Long Zodiac (see CHRON3, Chapter 15:1). Once again, our identification of the Round Zodiac's constellations is exactly the same as one finds in the works of N. A. Morozov ([544], Volume 6), N. S. Kellin and D. V. Denisenko ([376]), as well as T. N. Fomenko ([912:3]). We also see the same identifications in the work of the Egyptologist Sylvia Cauville ([1062]).

Constellation figures in the Round Zodiac comprise the zodiacal belt that looks like an oblate circle. It is circumscribed by a red line in fig. C5. We see a row of figures, all of which come from secondary horoscopes (mark the figures highlighted blue in fig. C5). Secondary horoscope symbols can also be found within the Zodiacal belt, qv in fig. C5.

4.4. Planetary symbols from the primary horoscope of the DR zodiac

Planetary figures from the primary horoscope of the Round Zodiac are highlighted in yellow (fig. C5).

The primary's horoscopes planets, with the exception of the Sun and the Moon, are drawn as wayfarers carrying planetary rods. All the figures one finds outside the zodiacal belt represented by a red line in fig. C5 pertain to secondary horoscopes exclusively. The planets of the primary horoscope are only drawn inside the zodiacal belt in this zodiac. However, we do find secondary horoscope planets among the planetary figures located within the zodiacal belt as well. We come up with two borderline cases when it isn't clear a priori whether the planetary symbol in question comes from the primary horoscope or a secondary one. Those are as follows:

1) The wayfarer with the head of a falcon standing on top of the figure of Capricorn.

2) The wayfarer with a human head standing on top of Virgo's ear of wheat. We mentioned this figure in CHRON3, Chapter 12. See also figs. 12.30, 12.31 and 12.32 above, as well as figs. 17.23 and 17.24.

Both of these wayfarer figures are standing on top of objects that neither resemble snakes, nor boats. In the present case, the implication could be that they

serve as planetary symbols in both primary and secondary horoscopes. Don't forger that boats and snakes were used as special "transposition symbols" in Egyptian zodiacs, which means that if we find them underneath planetary figures, the latter are always "transposed" elsewhere from the primary horoscope, qv in Chron3, Chapter 15;6. In rectangular Egyptian zodiacs various other symbols were used for this purpose – not just snakes and boats. However, the "transposition" rule may not work with round zodiacs whenever the object underneath a figure is neither a boat nor a snake.

The problem is that in round zodiacs the objects aren't arranged in a row the way they are in rectangular zodiacs, but rather hang one over the other. High density of symbols may result in some figures touching others. Therefore, if a planetary figure from a round zodiac has got some symbol underneath, and it cannot be identified as a special "transposition symbol", we have to consider different interpretation options for it.

It turned out that one of the two abovementioned "ambiguous" figures from the Round Zodiac of Dendera – namely, the one standing on top of Capricorn, comes from the primary horoscope, whereas the one standing on Virgo's war of wheat is a secondary horoscope figure. However, during the stage of preliminary analysis we allowed all possible identification options for these two figures, which is why both of them are highlighted with two colours at once in the coloured version of the Round Zodiac – yellow, which is the colour of the primary horoscope's planets, and blue (the secondary horoscope colour).

Let us now provide a consequential list of all the planets from the Round Zodiac's primary horoscope (see Chron3, Chapter 15:4) for the validation of interpretations used in our research.

Saturn is drawn as a male wayfarer with a planetary rod in between Virgo and Libra. The figure has a crescent or a pair of crescent-shaped horns on its head. More information about the reasons why we opine that Saturn in the primary horoscope is represented by this particular figure can be found in Chron3, Chapter 15:4.2. Our identification of Saturn in the Round Zodiac coincides with the ones made by N. A. Morozov ([544], Volume 6), N. S. Kellin and D. V. Denisenko ([376]), T. N. Fomenko ([912:3]) as well as S. Cauville ([1062]). See Chron3, Chapter 15:4.2 for more details.

Thus, Saturn is either in Virgo or Libra in the Round Zodiac, which makes said constellation comprise the planet's allowed position area.

N. A. Morozov had been of the opinion that Saturn was in Virgo on the Round Zodiac ([544], Chapter 6, page 658), likewise T. N. Fomenko ([912:3], page 661). The "best point" for Saturn will therefore be the middle of Virgo. Bear in mind that average deviations from the "best points" are only used in the preliminary comparison of solutions and aren't considered as a valid basis for rejection, qv in Chron3, Chapter 16:12.

Jupiter in the Round Zodiac's primary horoscope is the male wayfarer with a planetary rod between Cancer and Gemini.

This identification of Jupiter concurs with those suggested by N. A. Morozov ([544], Volume 6), N. S. Kellin and D. V. Denisenko ([376]), T. N. Fomenko ([912:3]) and S. Cauville ([1062]). The Egyptologist Sylvia Cauville is also of the opinion that this identification is validated by the hieroglyphic inscription near the head of the figure. Therefore, the allowed position area for Jupiter consists of Gemini and Cancer.

According to N. A. Morozov, who considered Jupiter to have been in Cancer, we shall choose the middle of Cancer as the "best point" for Jupiter.

Mars from the Round Zodiac's primary horoscope is the male wayfarer over Capricorn with a planetary rod in his hand. The fact that the figure stands for Mars is implied by the inscription over its head, as well as the comparison with the Long Zodiac, qv in Chron3, Chapter 15:4.7. Of course, the figure of Mars can also be ascribed to a secondary horoscope, since it hangs right over Capricorn, with its feet almost touching the constellation figure. As we already know, this is a transposition symbol often used in Egyptian zodiacs for indicating that the transposed figure has got nothing to do with the primary horoscope. There is really no choice in this case – we are forced to consider this figure of Mars to be part of the primary horoscope.

Let us emphasise that we have every right of doing so insofar as the general laws of symbolism in Egyptian zodiacs are concerned. As we stated above, in the zodiacs of the *round* type an object placed under-

neath a figure isn't necessarily a transposition symbol, unless it's a boat or a snake.

Our identification of Mars in the Round Zodiac coincides with that of N. A. Morozov ([544], Volume 6), N. A. Kellin and D. V. Denisenko ([376]), T. N. Fomenko ([912:3]) and S. Cauville ([1062]). It is also confirmed by the hieroglyphic inscription that we find here. See CHRON3, Chapter 15:4.7 for additional details.

And so, Mars is in Capricorn on the primary horoscope of the Round Zodiac. The allowed position area for Mars is therefore limited to the constellation of Capricorn, whose middle will obviously serve as the "best point" for Mars.

Let us continue.

Venus in the primary horoscope of the Round Zodiac is represented by a pair of female wayfarers carrying planetary rods, qv in CHRON3, Chapter 15:4.8. The figure in front has a leonine head. We find Venus right underneath the constellation figure of Aries; however, the thread that binds the two Piscean figures from the Round Zodiac together leads to Venus as well. Thus, Venus is either shown in Aries or Pisces.

Our identification of Venus in the Round Zodiac concurs with that of N. A. Morozov ([544], Volume 6), N. S. Kellin and D. V. Denisenko ([376]) as well as T. N. Fomenko ([912:3]), but differs from the identifications suggested by the Egyptologists ([1062]). See CHRON3, Chapter 15:4.8 for more details.

Visibility indicators as given in Egyptian Zodiacs are very important in case of Mercury and Venus, qv in CHRON3, Chapter 15:7. In the Round Zodiac we see no star over the heads of the female pair that represents Venus, which means was therefore invisible. The absence of a star in this part of the zodiac was verified with the aid of photographs and proven true.

Thus, Venus in the primary horoscope of the Round Zodiac is shown in either Aries or Pisces; these two constellations comprise the allowed position area for Venus in the astronomical solution.

Since N. A. Morozov, N. S. Kellin and D. V. Denisenko ([376]), and also T. N. Fomenko were of the opinion that Venus is shown in Aries, we shall consider the middle of Aries to represent the "best point" for Venus.

Let us now consider the next planet.

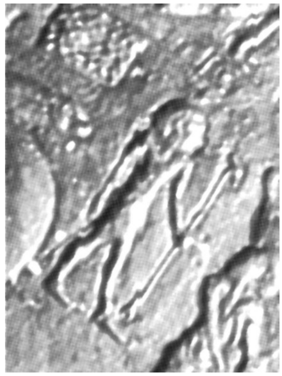


Fig. 17.25. The Round Zodiac of Dendera. Figure of Mercury in the primary horoscope. Modern photograph. Taken from [370], page 165.

Mercury in the Round Zodiac's primary horoscope is drawn as a two-faced man carrying a planetary rod located in between Pisces and Aquarius. We see a star over the head of the figure, which testifies to the visibility of the planet. A photograph of the Round Zodiac's fragment with Mercury in the primary horoscope can be seen in fig. 17.25.

Our identification of Mercury in the Round Zodiac concurs with the identification suggested by N. A. Morozov ([544], Volume 6), N. S. Kellin and D. V. Denisenko ([376]) as well as T. N. Fomenko ([912:3]); however, the Egyptologists are of a different opinion ([1062]). See more details in CHRON3, Chapter 15:4.9.

We end up with Mercury from the primary horoscope of the Round Zodiac in either Pisces or Aries. Thus, the allowed position area for Mercury in the astronomical solution is comprised of Pisces and Aquarius; the "best point" for Mercury shall therefore be the cusp of the two constellations.

We have thus identified every planet of the Round Zodiac, the two exceptions being the Sun and the Moon. One of the "borderline" figures, which can belong to either the primary or a secondary horoscope, remained unused – namely, the wayfarer with a rod observed over Virgo's ear of wheat. This figure should therefore be a fragment of the secondary autumn equinox horoscope, since this is where we find it (don't forget that the autumn equinox point is located in Virgo in every Egyptian zodiac, qv in CHRON3, Chapter 15:8.1). We shall mention this planetary figure below, in our account of the Round Zodiac's secondary horoscopes.

This was the last planetary figure of a wayfarer in the Round Zodiac. There are no other figures with planetary rods anywhere else in the zodiac, excepting the ones in boats, which belong to secondary horoscopes by definition. Let us now consider the Sun and the Moon. They were drawn as circles in Egyptian zodiacs, qv in CHRON3, Chapter 15:4.13–15.

The Sun and the Moon. Likewise the Long Zodiac, the Round one presents us with some ambiguity in identifying the Sun and the Moon. The problem is that we see three circles here at once. Each one of them may serve as a solar or lunar symbol in the primary horoscope. Two of the circles are found in Pisces, and one more in Libra. We have therefore considered all possible identification options for the solar/lunar circles. The third one is left unidentified to be subsequently ascribed to one of the secondary horoscopes.

The final version, which is the one that yielded an exhaustive solution, proved to be in perfect concurrence with the solar and lunar symbols that we already identified as such in the Long Zodiac. We are referring to the circle in Libra in particular, which looks just like the one from the Long Zodiac and represents the Moon here as well – a full one. The circle in Pisces with a woman making an offering drawn inside it is just like the circle in the same constellation that we saw in the Long Zodiac, the sole difference being that in the latter case it is a man who makes the offering. Keep in mind that this circle turned out to be a solar symbol from the secondary horoscope of spring equinox in the Long Zodiac, whereas the male figure represents Jupiter, which was close to the Sun during the days of the spring equinox, making a "sacrifice to the Sun", as it were. We observe the very same phenomenon in the Round Zodiac, with Venus making the "sacrifice" instead of Jupiter – hence a female figure and not a male one. The symbols are identical in every other respect.

Finally, the Sun from the primary horoscope turned out to be the circle between Aries and Pisces in the exhaustive solution of the Round Zodiac. We see an eye inside the circle; the meaning of this symbol was discussed at length in CHRON3, Chapter 15:4.14. Here it is probably a reference to the Sun being in the immediate vicinity of the Alpha from the Aries constellation – the star that was known as the "Eye of the Ram" in ancient astronomy ([544], Volume 6, page 657).

Step 2, qv in CHRON3, Chapter 16:7.2. Having defined the planets of the primary horoscope – complete with the bulk of multiple options for the Sun and the Moon, we used the Horos software to calculate all possible dates for which the disposition of planets on the celestial sphere would coincide with the way their symbols are arranged in the Round Zodiac, in case of a single identification option, at least. The rigid criterion applied at this stage is the exact correlation between the planetary order in the solution and the zodiac. Solutions that didn't satisfy to this criterion were rejected instantly. We came up with several dozen preliminary dates scattered across the solution search interval between 500 B.C. and 1900 A.D. – see CHRON3, Chapter 16:7. These dates were subsequently tested for compliance with the specifications of secondary horoscope and planetary visibility indicators, qv in CHRON3, Chapter 16:7.

4.5. Secondary horoscopes in the DR zodiac

4.5.1. Autumn equinox horoscope in the DR zodiac

The horoscope of the autumn equinox can be found in the vicinity of Virgo, qv in fig. 17.23 and fig. C5. It includes the following symbols:

1) Male wayfarer with a planetary rod hanging over Virgo's ear of wheat. This figure can be seen above, in Chapter 12 of CHRON3 (figs. 12.31 and 12.32).

2) The bird that sits on the tail of the snake serving the figure of Leo as a dais. It is visible very well in the photograph of a small fragment of the Round Zodiac (see fig. 17.26). The bird ended up right under the feet of the "auxiliary" Virgo standing on Leo's tail. It can therefore relate to Leo as well as Virgo. See CHRON3, Chapter 15:1.5-6 in re the "auxiliary Virgo figure" in Egyptian zodiacs.

3) Five figures found under the constellations of Libra, Virgo and Leo in the secondary horoscope row – bear in mind that this row of figures encloses the Zodiacal belt of the Round Zodiac in a semicircle, qv in fig. C5.

These five figures form the "autumn equinox procession" in the Round Zodiac.

The procession is headed by the symbol that we already mentioned in CHRON3, Chapter 15:8.1,

namely, a man sitting on a stool with his arms reaching forward symmetrically. He is holding two identical vessels, one in each hand. These are likely to symbolise the daytime and the night time, the meaning of the entire symbol being that day equals night in the point of the equinox – this is indeed the case, as we know. The figures seen in front of the equinox symbols belong to another procession – the summer solstice one; we shall discuss it below.

We see the equinox symbol followed by the symbol of the New Year, which we have also mentioned earlier. It looks like a woman sitting on a chair and holding an infant on her palm. This symbol corresponds to the autumn equinox day perfectly, which used to fall over the very beginning of the year in Egyptian calendars – a September year, as we must remember, qv in CHRON3, Chapter 15:12.

Next we see the figure of Saturn carrying a scythe from the secondary horoscope of the autumn equinox. Since Saturn cannot travel too far on the celestial sphere over the course of a single year, we see the same planet from the primary horoscope right above the one considered presently. It looks exactly the same, albeit equipped with a planetary rod instead of a scythe.

Next comes Leo, whose paws rest on the autumn equinox plaque. Such plaques mark equinox points in the zodiacs from Dendera. The other plaque looks exactly the same; we find it in Pisces, or the vernal equinox point.

However, Leo is hardly drawn here for the mere purpose of resting its paws on the equinox plaque. It is followed by a female figure; we see it right next to Leo's tail. The woman has leonine legs and a tail, and there's a tall hat on her head. She holds a cup on her palm. Such cups held on palms are plentiful in the Lesser Zodiac of Esna (EM), where they accompany secondary horoscope planets. What we see here must therefore be one of the planets from the secondary horoscope, and it is perfectly clear which one – a woman with a leonine body can only represent Venus, since the symbol of Venus in the Egyptian zodiacs is a lioness, qv in CHRON3, Chapter 15:4.8.

The symbolic meaning of this couple is perfectly clear – Venus was in Leo on the day of the autumn equinox.

This is what the entire procession of five figures is telling us. In the secondary horoscope of the autumn equinox we see Saturn in the same position as it occupies in the primary one (the constellation being either Virgo or Libra), as well as Venus in Leo.

Fig. 17.26. The Round Zodiac of Dendera. Figure with a rod standing over the ear of wheat held by Virgo, and the bird underneath the "second Virgo" that stands on Leo's tail. Modern photograph. Taken from [370], page 165.

Let's see whether the secondary horoscope figures that we listed in the beginning might tell us anything – the male figure that stands over Virgo's ear of wheat and the bird underneath the feet of the "auxiliary" Virgo.

First and foremost, we must emphasise that the ear of wheat in Virgo's hands isn't a mere detail of the drawing – it represents the Alpha of Virgo, one of the most famous stars in ancient astronomy. Other names of this star are Spica and Virgo's Ear of Wheat ([704]). In the old star charts one would normally see this star crowning Virgo's ear of wheat.

Therefore, the fact that our planet is standing on top of the ear of wheat implies that it had been very close to Spica on the day of the autumn equinox.

What planet could it be? We discussed this issue at length above, in Chapter 12 of CHRON3. The planet is Mercury.

Indeed, there is a hieroglyphic inscription over the head of the figure as well as the star that indicates its visibility. The inscription can be seen with perfect clarity in fig. 12.32 cited in CHRON3, Chapter 12. One can also make it out in the photograph of this zodiacal fragment in fig. 17.26.

A brief table of Egyptian hieroglyphs, which however suffices in order to read the name of the planet in this inscription, is given in figs. 17.27 and 17.28.

The inscription over the head of the planetary figure consists of three hieroglyphs, qv in fig. 12.32:

1) The curved line hieroglyph that stands for the sound S ([370], page 19; see also fig. 17.28).

2) The human leg hieroglyph that stands for the sound B ([370], page 19; see also fig. 17.27.

3) The small-handled ladle hieroglyph that stands for the sound K ([370], page 19; see also fig. 17.28).

The name of the planet is therefore SBK. Seeing as how vowels are omitted from Egyptian transcriptions of names as a rule, qv in the section below, this name can be read as Sebek. Egyptologists have the tradition of replacing the omitted vowels in Egyptian words with the letter E, qv in [1378:1], page 71. According to H. Brugsch, Sebek is the name of Mercury ([544], Volume 6, page 697).

We must point out that the planetary figure in question corresponds well with the usual drawings of Mercury in Egyptian zodiacs – it is a male wayfarer with a human face, qv in CHRON3, Chapter 15:4.9. Furthermore, in the work of S. Cauville, a modern French Egyptologist, this figure is also identified as Mercury ([1062], page 29).

It has to be mentioned that the figure of Mercury as discussed above is misrepresented in the Napoleonic album ([1100]). Firstly, it is shifted sideways from Virgo's ear of wheat, qv in fig. 12.30 in CHRON3, Chapter 12. Secondly, the hieroglyphic inscription over its head is distorted to a great extent – we see a single curved snake instead of the two first hieroglyphs in this inscription. We mentioned this above in CHRON3, Chapter 12, and feel obliged to reiterate, since this error from the Napoleonic album eventually led to a misinterpretation of this figure's identity in [912:3], where it is considered to represent Jupiter.

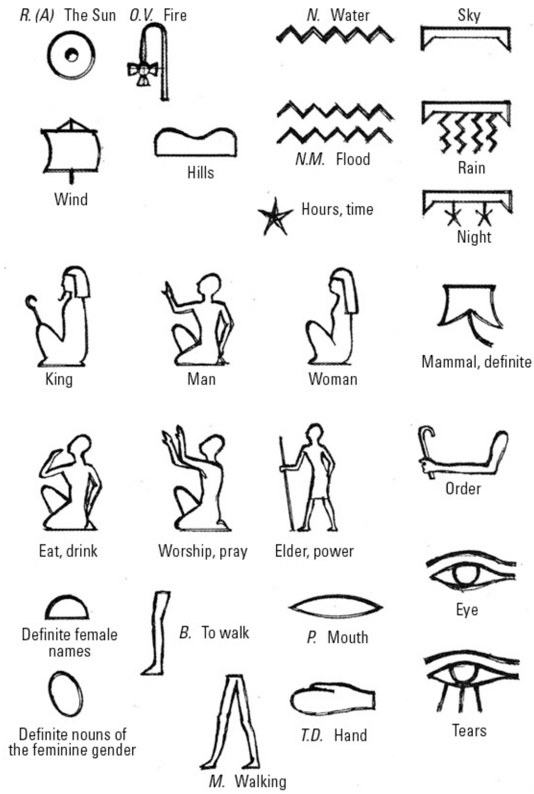


Fig. 17.27. Examples of Egyptian hieroglyphs, with their phonetic meanings given in cases where a hieroglyph doesn't represent a single word, but rather a letter thereof (name transcriptions, for instance). Many of the hieroglyphs "have phonetic meaning and stand for a consonant, or several consonants… The sounds and the meanings of the sign were deciphered after a comparison of many names and words transcribed in hieroglyphs with respective Greek or Coptic words" ([370], page 19). First half of the table. Taken from [370], page 19.

COROLLARY. One sees the following in the secondary horoscope of autumn equinox from the Round Zodiac:

Saturn is in the same position as in the primary horoscope – in Virgo or Libra.

Mercury is right over Virgo's ear of wheat, or very close to the Alpha of Virgo. Old names of this famous star include those of "Spica" and "Virgo's Ear of Wheat".

Venus is in Leo.

Another planet – or, possibly, the Sun, is drawn in

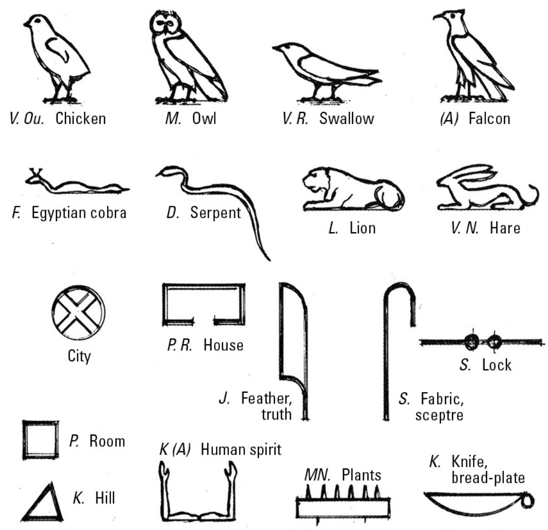


Fig. 17.28. Examples of Egyptian hieroglyphs, with their phonetic meanings given in cases where a hieroglyph doesn't represent a single word, but rather a letter thereof (name transcriptions, for instance). Second half of the table. Taken from [370], page 19.

either Virgo or Leo as a bird underneath the feet of the "auxiliary Virgo".

For the sake of completeness, we feel obliged to point out that there's another tiny figure of a secondary horoscope planet in this part of the Round Zodiac. It is sitting on a stool over Leo and holding a whip in its hands. However, this planet is just as likely to come from the secondary horoscope of summer solstice, since it is located right in between the two areas "covered" by these horoscopes. Indeed, in the exhaustive solution that we came up with eventually, it turned out to be a planet from the horoscope of summer solstice. We shall therefore mention it below, when we consider this horoscope specifically. Mark that during the verification of preliminary solutions we tried to ascribe the symbol to summer solstice as well as autumn equinox; it revealed itself as a part of the former.

4.5.2. Winter solstice horoscope in the DR zodiac.

We already considered the secondary horoscope of winter solstice from the Round Zodiac of Dendera above, in CHRON3, Chapter 15:5.2. Let us merely repeat the corollary that we made in re the content of the horoscope there.

Apart from the standard symbols of the minimal secondary horoscope integrated into the figure of Sagittarius, we see three planets in the secondary horoscope of winter solstice in the Round Zodiac. However, one of them might be the Sun, which should be here on the day of winter solstice at any rate. There are two or three planets here apart from the Sun, one of them identified as Mars and another likely to stand for Venus.

4.5.3. Spring equinox horoscope in the DR zodiac

The secondary horoscope of spring equinox in the Round zodiac depends on the chosen interpretation, since it has to employ the circles in Pisces that aren't part of the primary horoscope.

Let us describe the horoscope in the interpretation that eventually led us to the final solution. That is, the large circle in Pisces with a female figure inside it pertains to the secondary horoscope of spring equinox. In this case, it should naturally stand for the Sun. The conspicuously large size of this circle corresponds to the idea of the spring equinox as a vernal feast of the Sun.

However, in the present case the secondary horoscope of spring equinox is just the same in the Round Zodiac as it is in the Long one. The only difference between them is the fact that the planet "making a sacrifice for the feast of the sun" is male in the Long Zodiac and female here. Therefore, the closest planet to the Sun had been Venus in the prime of its matutinal visibility.

4.5.4. Summer solstice horoscope in the DR zodiac

This horoscope in the Round Zodiac consists of several figures found inside the zodiacal belt, as well as the "summer solstice procession" in the secondary horoscope row. There are four figures in the procession; one of them has a small bird underneath its feet.

Let us begin with the figures from within the zodiacal belt. There are two of them; the first one is a small male figure. We find it right here in Gemini, near the constellation figure's face, with its feet located at the waist level of Gemini; the figure is holding two short sticks of some sort, one of them T-shaped. It is also wearing a peculiar headdress – it looks like two

broad feathers facing upwards. One of the "second Mercury's" figures from the Long Zodiac has a similar headdress, which means that the small figure is likely to represent Mercury here as well. However, we can make no definite claims in this respect.

The second figure was already mentioned above - a small figure sitting on a stool right over Leo with a tall hat on its head. The gender of the figure is hard to fathom; the "step length litmus test" that provides for easy distinction between male and female figures in Egyptian zodiacs isn't applicable here, for the figure is sitting with its legs held together.

We see two planets in the horoscope so far. The first one is male, located in either Gemini or Taurus. It is likely to be Mercury, but we can't be perfectly certain. The second is either male or female, and we find it in Leo.

Let us now consider the procession in the secondary horoscope row. Right underneath Gemini, near the middle of the procession, we find the pole with a solar bird on top of it. This is the Egyptian symbol of summer solstice that is already known to us quite well. It represents the Sun at its absolute peak, which can only happen on the day of summer solstice. We see another summer solstice symbol nearby, on the left of the pole with the bird – a calf in a boat, qv in CHRON3, Chapter 15:8.4.

We also see several figures meant to represent the planets of this secondary horoscope here, one on either side of each of the two summer solstice signs.

On the right of the pole with a bird (possibly a reference to morning visibility from the side of Taurus) we see a male planet of some sort. It is a large figure of a walking man taking large steps, with a whip on his shoulder and a planetary rod in his hand. There is a bird of some sort at his feet, although its exact species remains enigmatic – it bears distant semblance to a hen or a goose, possibly a peacock.

A whip on the shoulder may be an attribute of either Mars or Jupiter, whereas the goose is a symbol of Mars. The disposition of the planet suggests that the latter should be identified as Mars, although we can make no certain claims so far.

The exact position of this planet on the ecliptic remains unclear, since the planets from the secondary horoscope row of the Round Zodiac aren't always related to the primary constellation signs closest to them. This relation is only present in case of the constellation that contains a solstice or equinox point – Virgo and Gemini in the present case. In general, the row of secondary horoscope figures of the Round Zodiac has a specific marking and is hardly linked to the main zodiacal belt at all. The "autumn equinox procession" considered above serves as a good example. We have witnessed it to possess a Leo figure of its very own, which can be seen underneath the primary zodiac's figure of Libra – very far away from Leo in the primary horoscope.

Let us return to the "summer solstice procession" that we find underneath the sign of Gemini. On the far left of the procession we see a woman with a strung bow in her hands. She is preparing to fire an arrow over the head of the horizontal figure of Taurus. Next we see the figures from the secondary horoscope of autumn equinox as mentioned above – the New Year's symbol et al.

The woman firing an arrow over the head of the incumbent figure of Taurus is a symbol which we shall frequently encounter in Egyptian zodiacs, qv in CHRON3, Chapter 15:8.4. It stands for Venus in secondary horoscopes. We know nothing of why the figure prepares to fire an arrow from the bow; the astronomical meaning of this action remains beyond our ken.

We find Venus on the other side of the solar symbol than the one where we see the first planetary figure (probably Mars), so it is likely to have been drawn in opposite visibility position as well – apparently vespertine. Once again, we cannot determine the constellation that housed Venus.

The interpretation of this secondary horoscope is as follows. We see some planet in either Gemini, next to the Sun, or in Taurus – possibly Mercury. Another planet (whose shape tells us nothing) was in Leo. Some male planet was observable perfectly well in matutinal visibility – Mars, most probably. Venus was in vespertine visibility.

4.6. The exhaustive solution for the Round Zodiac: morning of 20 March 1185 A.D.

We only came up with the complete solution for a single interpretation option of the Round Zodiac's primary horoscope. The solution is unique – morn-

ing of 20 March, 1185. The fact that the observations were conducted in the morning plays a key role – planetary visibility conditions aren't met for evening observations. Let us cite the final interpretation version of the Round Zodiac that gave us the exhaustive solution:

DATA FOR THE HOROS PROGRAM

Zodiac: Round Zodiac of Dendera (DR).
Interpretation option: Moon in Libra.
Interpretation option code: DR9.
Planetary positions in the primary horoscope:
Sun in Pisces
Mercury in either Aquarius or Pisces
Saturn in either Virgo or Libra
Moon in Libra
Mars in Capricorn
Venus in either Aries or Pisces.
Jupiter in either Cancer or Gemini.
The borders of all possible positions can be crossed by a value of up to 5 arc degrees.
The planetary order on the ecliptic (ordered by latitude, the minimal value being on the left):
Venus Jupiter Saturn Moon Mars Mercury Sun

DATA

	Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
# FROM:	10.5	5.5	5.0	2.0	9.0	11.0	10.0
# TO:	0.5	7.5	7.0	4.0	10.0	1.0	12.0
# BEST POINTS:	11.5	6.5	5.5	3.5	9.5	.5	11.0

END OF DATA

NB: Planetary positions are given on the planetary scale (see CHRON3, Chapter 16:10).

Average deviation of the planets in the exhaustive solution from their "best points" equalled a mere 8.5 degrees, which is less than one third of a zodiacal constellation's length. The correspondence is all but ideal, which should be telling us that planets hit the environs of their "best points" with very high precision indeed, qv in CHRON3, Chapter 16:12.

Let us proceed to cite the calculated planetary positions for the 19, 20 and 21 March 1185 A.D. The dates are given according to the Julian calendar and transcribed as year/month/day, and also transcribed as Julian days (JD) as used for astronomical calculations ([393], page 316. See CHRON3, Chapter 16:4).

Planetary positions are given in degrees on the ecliptic J2000 (first line) and also according to the "constellation scale" (second line). The third line contains the name of the constellation that housed the planet. See CHRON3, Chapter 16:4 for more details.

The full moon fell on the night of 19-20 March in 1185 (as calculated with the Turbo-Sky program).

THE EXHAUSTIVE SOLUTION OF THE ROUND ZODIAC OF DENDERA (PRIMARY HOROSCOPE)

Julian day (JD) = 2153957.00
Year/month/day = 1185/3/19

Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
377.0	214.3	178.0	142.1	318.4	29.2	352.9
11.76	5.97	5.08	3.94	9.60	0.11	11.16
Pisces	Vir/Lib	Vir/Leo	Can/Leo	Capr.	Aries	Pisces

Average deviation from "best points" equals 9.9 degrees.

Julian day (JD) = 2153958.00 (full moon in Libra)
Year/month/day = 1185/3/20

Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
377.9	226.3	177.9	142.1	319.2	30.5	354.4
11.78	6.51	5.08	3.94	9.63	0.16	11.20
Pisces	Libra	Vir/Leo	Can/Leo	Capr.	Aries	Pisces

Average deviation from "best points" equals 8.5 degrees (local minimum).

Julian day (JD) = 2153959.00
Year/month/day = 1185/3/21

Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
378.9	238.1	177.9	142.0	319.9	31.7	355.9
11.81	7.05	5.08	3.94	9.66	0.21	11.23
Pisces	Sco/Lib	Vir/Leo	Can/Leo	Capr.	Aries	Pisces

Average deviation from "best points" equals 10.5 degrees.

The Round Zodiac of Dendera (DR). Verification table for the solution of 20 March 1185 A. D.								
Visibility of Mercury	Visibility of Venus	Autumn equinox	Winter solstice	Spring equinox	Summer solstice	The Passover Full Moon	Additional scenes	*Notes*
		S E P	T E M B	E R	Y E A R			
Mercury rising in Cairo on 19.03.1185. S. S. = 12°. M = +0.7. *Visible.* $\oplus$	Venus in vespertine visibility. S. S. = 12°, M = -3.4. Venus is *invisible* in the morning. $\oplus$ *For the morning.*	12 September 1184 A.D. Sun in Virgo (5.3). Mars next to the Sun (distance = 2°) => invisible. $\oplus$ Mercury in Virgo, next to Spica (distance = circa 1°). *Visible* on 10.09.1184. $\oplus$ Venus in Leo, next to Regulus. *Visible.* $\oplus$ Saturn in Virgo on the morning of 12 September. S. S. = 12°. M = +0.9. $\oplus$ Jupiter in Leo. $\oplus$	12 December 1184 A. D. Sun in Sagittarius (8.4). Mercury in Sagittarius on 4.12.1184. S. S. = 9°. M = +0.9. Visible in the morning, later disappeared from sight. 12.12.1184. S. S. = 4. M = +1.0. *Invisible.* Venus in Sagittarius. 12.12.1184. S. S. = 10. M = -3.4. *In matutinal visibility.* Mars in Scorpio. Visible in the morning. $\oplus$	14 March 1185 A. D. Sun in Pisces (11.6). Venus in Pisces, vespertine visibility. S. S. = 10°. M = -3.4. $\oplus$ Mercury in Aquarius, 2.5 times further away from the Sun than Venus. $\oplus$ Mars in Capricorn (9.5). => The offering to the Sun is made by Venus – the female figure. $\oplus$ $\oplus$	12 June 1185 A. D. Sun in Gemini (2.4). Venus in Cancer. $\oplus$ Mercury is *invisible* (S. S. < 1°). M = +4.2. $\oplus$ Jupiter in Leo, next to Regulus (distance < 1°). M = -1.3. $\oplus$ Mars in Pisces. M = +0.1. $\oplus$ $\oplus$	The Passover Full Moon in Libra on 20 March (the day of the horoscope) = circle in Libra is simultaneously the Moon in the primary horoscope and the Passover Full Moon. $\oplus$	*None.*	Interpretation code DR8. *Morning horoscope.* The astronomical Passover Full Moon on the night of 19-20 March. The Passover Full Moon on 18 April according to the Paschalia. Easter according to the Paschalia (21 April). $\varnothing_{ref}$ = 9° + + + + + + +

Fig. 17.29. The verification table for the complete solution of the Round Zodiac from Dendera – morning of 20 March 1185 A.D. Abbreviations used: S. S. – solar submersion rate transcribed in arc degrees (see CHRON3, Chapter 16:7, Step 3-B); M – planetary luminosity; a fraction between 0 and 12 in parentheses is the calculated position of a planet on the "constellation scale", qv in CHRON3, Chapter 16:10. Bottom right – the result of comparing the solution with the zodiac as well as the average distance between planets and their "best points", qv in CHRON3, Chapter 16:11 and 16:14.

4.7. Verification table for the exhaustive solution of the Round Zodiac

Let us cite the verification results for the exhaustive solution of the Round Zodiac from Dendera discovered by the authors (the morning of 20 March 1185). The verification table of the solution can be seen in fig. 17.29. It indicates the degree of correspondence between the solution and the source data from the Round Zodiac. Bear in mind that we use the term "exhaustive solution" for referring to a solution that has a plus sign in every column of its verification table, which implies perfect correlation with the Egyptian zodiac when every single condition is met, qv in CHRON3, Chapter 16:14.

Let us give an overview of the verification table and the content of its columns (see fig. 17.29).

The first column tells us that Mercury was visible. On the morning of 20 March 1185 A.D. Mercury was visible perfectly well in Cairo, let alone Luxor. The submersion rate of the Sun had equalled 12 degrees when Mercury rose in Cairo. The planet's luminosity had equalled 0.7, which made Mercury resemble the brightest of stars.

This figure is all but identical to the representation of Mercury from the Round Zodiac, which has got a star over its head. This is why we can draw a plus sign in the first table of the verification table.

The second column reflects the visibility of Venus. The two women that symbolise Venus in the Round Zodiac have no stars over their heads, which means that Venus had been out of the observer's sight on the date transcribed in a given horoscope.

Indeed, on 20 March 1185 Venus had been below the horizon and hence invisible at dawn - it only appeared in the sky at dusk.

We shall therefore draw another plus sign in the second column of the verification table (on the condition that the horoscope was compiled as a result of matutinal observations).

The third column represents the secondary horoscope of autumn equinox.

As above, we are considering a September year – one that began in September 1184 A.D. and ended in August 1185 A.D. Autumn equinox fell on the 12 September 1184 A.D., qv in Annex 5. However, as we already explained above, this date couldn't be estimated with enough precision before, and one can encounter six-day discrepancies between real and estimated dates in XIV century books. We shall therefore regard the planetary positions for the interval between 6 and 18 September. Indeed, on 10 September 1184, a mere two days before the exact autumn equinox date, the planets that had been near the Sun that day were arranged in the sky – in strict correspondence with the secondary autumn equinox horoscope of the Round Zodiac.

Planetary positions calculated for 10 September 1184 A.D. are as follows.

Julian day (JD) = 2153767.00
Year/month/day = 1184/9/10

Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
185.8	227.4	174.7	143.3	184.7	152.4	204.4 (longitude J2000)
5.27	6.56	5.00	3.99	5.25	4.29	5.73 (constellation scale)

A representation of the celestial sphere as observed from Cairo on 10 September 1184 can be seen in fig. 17.30, where we see the morning and evening horizons of Cairo with the sun submersed by 9 degrees. The stars and planets between the two horizons were rendered invisible by the sunshine. Let us provide a list of planets that could be seen on that date – at dusk and at dawn.

The following planets were visible at dawn (listed in accordance to their distance from the Sun):

Saturn (M = +0.9) – in its rightful primary horoscope location in Virgo;

Venus (M = –3.8) – near the beginning of Leo next to Regulus (Alpha of Leo);

Jupiter (M = –1.4) – in Leo.

The only planet visible at dusk was Mercury (M = +0.98) near the very horizon. The submersion of the Sun hadn't been all that deep for the moment Mercury set – just 9 degrees. Nevertheless, the planet was bright enough to be seen, considering how deep the Sun had set. It could be observed right over the horizon at dusk. Furthermore, Mercury had been very

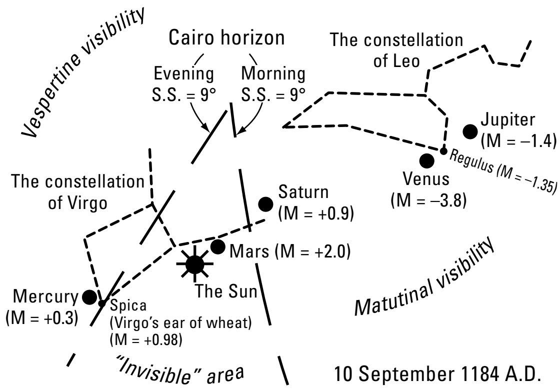


Fig. 17.30. A representation of the sky in the morning and in the evening for the autumn equinox days of 10 September 1184 as seen from Cairo. One sees the horizon at dusk and at dawn; the stars and the planets in the celestial area between them were rendered invisible by the sunshine. Calculated with the astronomical program Turbo-Sky. The drawing is approximated.

close to Spica (the "Ear of Wheat" star in Virgo), that day, the distance between the two equalling approximately 1 degree.

Mars had also been close to the Sun – the distance between the two celestial bodies didn't exceed two degrees. It had been rendered completely invisible by the sunshine on each of the days comprised in the autumn equinox interval that we have under considerations.

We ought to compare this situation to what one sees in the representations of the Round Zodiac. We have to remind the reader of the components that add up to the secondary horoscope of autumn equinox in the Round Zodiac (qv in CHRON3, Chapter 17:4.5.1 above):

Mercury is over Virgo's ear of wheat – very close to Spica, in other words. Perfect correspondence.

Saturn retains its primary horoscope position in either Virgo or Libra. This fits the solution as well. Nothing to be surprised about – this is simply an astronomical implication of the primary horoscope.

Venus in Leo. Perfect correspondence.

Another planet (or, possibly, the Sun) is drawn in either Virgo or Leo as a bird underneath the feet of the "auxiliary Virgo". This also fits our solution well, including invisible Mars one finds right next to the Sun in Virgo. Actually, it is possible that the bird "hiding" underneath the feet of the "auxiliary" Virgo figure represents Mars – or, alternatively, the Sun in Virgo, with Mars remaining beyond the scope of this horoscope. Thus, we see perfect concurrence with the astronomical solution.

Thus, Jupiter is the only planet we failed to have located in the Round Zodiac, as it was indicated in the solution. All other planets are right where they should be. However, Jupiter had been even further away from the Sun than Venus on the date indicated in the solution, the latter planet drawn as the last figure of the "autumn equinox procession" in the Round Zodiac. Jupiter failed to have become part of the "procession" as a result.

Jupiter is nevertheless present in the Round Zodiac. Let us recollect the tiny figure sitting on a stool in front of Leo. We were saying that it might either pertain to the secondary horoscope of the autumn equinox, or that of the summer solstice. Our solution demonstrates that this figure relates to both horoscopes and represents Jupiter. This planet doesn't usually stay in the same constellation this long – however, it had looped a loop in Leo that year, which made it stay there for a whole year.

As you can see, the correspondence is ideal in case of Jupiter as well.

We shall therefore draw another plus sign in the third column and proceed to the next one.

Fourth column – secondary horoscope of winter solstice.

Winter solstice of the September year under study falls on 12 December 1184, qv in Annex 5. Having added a few days at each end, we came up with the period of circa 6-18 December 1184. This is the interval that shall be used in our astronomical environment research as conducted for the solar area in particular.

Mercury remained near the Sun on every day included in the interval under consideration, rendered invisible by solar luminosity on every date postdating 4 December 1184, when one could still see it above the horizon, and positioned with the utmost convenience for the observer at that. We shall therefore specify planetary positions for two dates – 4 December 1184 as mentioned above, and 12 December 1184, when Mercury was already beyond visibility. Other

planets remained in their former positions, more or less, with the exception of the Moon.

We must note that the Moon was new on the 4-5 December and hence invisible. It only appeared in the sky for the first time on 6 December between Sagittarius and Capricorn in vespertine visibility.

Julian day (JD) = 2153852.00
Year/month/day = 1184/12/4

Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
271.2	265.6	182.4	151.9	242.1	257.9	261.2 (longitude J2000)
8.13	7.97	5.19	4.27	7.19	7.71	7.82 (constellation scale)

Julian day (JD) = 2153860.00
Year/month/day = 1184/12/12

Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
279.4	369.0	182.6	151.7	247.7	268.0	273.7 (longitude J2000)
8.37	11.56	5.20	4.26	7.37	8.04	8.20 (constellation scale)

In fig. 17.31 we cite the positions of planets that were close to the Sun on 4 December 1184 A.D., when Mercury had still been visible. There were three planets in the sky at dawn – Mercury in Sagittarius at the very crack of dawn, Venus at the cusp of Sagittarius and Scorpio, and Mars in Scorpio, right next to Antares - the brightest star of the constellation. All these planets were in matutinal visibility; there had no vespertine planets with Jupiter in Leo and Saturn in Virgo. Both of them were too far away from the Sun and hence became omitted from the secondary horoscope area.

Let us now recollect the planets included in the winter solstice zodiac of the Round Zodiac, as analysed above:

We see three planets. One of them is a figure sitting

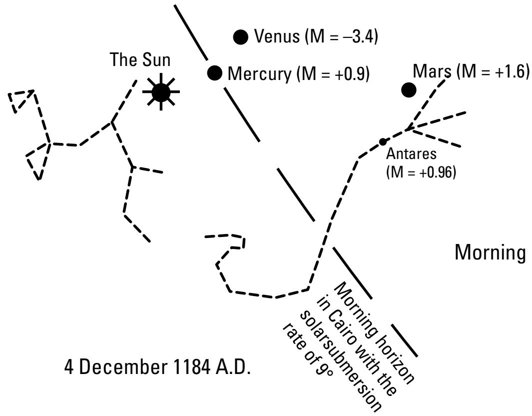


Fig. 17.31. Planets that had been close to the Sun on 4 December 1184, on the last day of Mercury's visibility before the winter solstice that took place on 12 December. We see the morning horizon as observed from Cairo. Calculated in Turbo-Sky. The drawing is approximated.

on a stool, in Scorpio, with a circle over its head – the Sun, perhaps, or one of the planets. Mars is also included in this horoscope – and, possibly, Venus as well.

This corresponds with our solution quite well. Indeed, we see a total of three planets near the Sun, among them Mars and Venus. Mars was in Scorpio; its representation in the Round Zodiac is a large figure in a boat that holds a planetary rod. This is the same figure as one sees in Scorpio. A propos, its appearance is quite in line with how Mars is drawn in the primary horoscope of the Round Zodiac. Both figures have the head of a falcon.

Over the head of Mars we see a sitting figure that we hypothetically identified as Venus above. Our solution confirms this hypothesis – Venus was between Mars and the Sun.

Finally, the third planet of this secondary horoscope (drawn as a man with a wand in his hand) may well be identified as Mercury in our solution, if we are to remember that Mercury was often drawn as a male wayfarer with a human face in Egyptian zodiacs, qv in CHRON3, Chapter 15:4.9.

Therefore, we have to draw another plus sign in the fourth column of the verification table for this solution.

Fifth column – secondary horoscope of spring equinox.

Spring equinox fell over 13-14 March in 1185 – it had preceded 20 March, the date transcribed in the primary zodiac, by just one week, qv in Annex 5.

Let us cite the planetary positions for 14 March 1185 A.D.

Julian day (JD) = 2153952.00
Year/month/day = 1184/3/14

Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
372.0	151.7	178.4	142.3	314.7	383.1	345.9 (longitude J2000)
11.64	4.26	5.09	3.95	9.47	11.91	10.96 (constellation scale)

Since the spring equinox had been very close to the date of the primary horoscope, all the planets (except for the Sun and the Moon) virtually in their "main" positions as indicated in the primary horoscope. Therefore, the secondary horoscope of spring equinox is just the same in the Round zodiac as it is in the Long one – it consists of nothing but the Sun that looks like a large circle in Pisces, as well as another planet, one that was visible best in its proximity to the Sun and therefore considered to have been "making an offering" during the feast of the Sun.

Calculated planetary positions as cited herein demonstrate Venus to have been the closest planet to the Sun on the spring equinox day of 1185; nevertheless, it hadn't approached the sun close enough to disappear in the solar radiance. Calculations performed with the aid of the Turbo-Sky program demonstrate that Venus was perfectly visible at dusk on that date. The submersion rate of the Sun had equalled 10 degrees when Venus set, the luminosity of the latter equalling –3.4, and so it must have looked quite spectacular at dusk. There were no other planets near the Sun on any of the days included in the interval under consideration. There are no further doubts about the identity of the planet that makes an offering to the Sun – it is Venus. This is exactly what we see in the secondary horoscope of spring equinox from the Round Zodiac.

Yet again we see a perfect correlation with the Round Zodiac, drawing a plus sign in the fifth column as well.

Sixth column – secondary horoscope of the summer solstice.

Summer solstice fell over the 12-13 June 1185, qv in Annex 5.

Let us cite the planetary positions for 12 June 1185:

Julian day (JD) = 2154043.00
Year/month/day = 1184/6/13

Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
99.8	264.3	176.9	149.3	381.2	133.7	98.5 (longitude J2000)
2.35	7.92	5.06	4.19	11.87	3.60	2.31 (constellation scale)

In fig. 17.31a we see the planetary disposition in the solar area of the zodiac for the summer solstice day of 12 June 1185. We witness all of the following to be true for the day in question:

1) The only planet to accompany the Sun in Gemini is Mercury - obscured by solar rays, since the submersion rate of the Sun for the moment when Mercury crossed the horizon had equalled one degree maximum, and the planet's luminosity had been rather low – a mere +4.3.

2) Jupiter was in Leo, near Regulus. The planet

Fig. 17.31a. Planets in the solar area distributed along the ecliptic on the summer solstice day of 12 June 1185. All of them were visible well, with the sole exception of Mercury; the latter had been right next to the Sun, and couldn't be seen from any part of the Earth. Calculated in Turbo-Sky. The drawing is approximated.

was very bright, its luminosity equalling –1.3 on the photometric scale. Jupiter had been in its vespertine visibility phase.

3) Venus (M = –3.8) was in Cancer, its visibility being vespertine.

4) Mars was the only planet in matutinal visibility. Notwithstanding the rather formidable distance between the planet and the Sun in Pisces, one sees no other planets between Mars and the Sun, which means that Mars was the closest planet to the Sun one could observe at dawn. Its luminosity was exceptionally high that moment, equalling 0.1. Mars was therefore brighter than any star (with the exception of Sirius), roughly equalling Arcturus in luminosity. However, since both Sirius and Arcturus had set below the horizon two hours before the Sun rose in Cairo in the morning of 12 December 1185, Mars can be considered to have been *the brightest star in the sky that day.*

Now let us return to the secondary horoscope of summer solstice from the Round Zodiac:

1) There was a certain planet in either Gemini or Taurus, next to the Sun – probably Mercury, which concurs with our solution perfectly.

2) Leo housed another planet in vespertine visibility, which is already known to us as Jupiter, and the very same figure simultaneously represents this planet in the autumn equinox horoscope, qv above. This also concurs with our solution perfectly.

3) Venus was in vespertine visibility – likewise in our solution, which places it in Cancer, near the Sun. The visibility of Venus had been excellent that day.

4) There was a male planet in perfect matutinal visibility – most probably Mars. This figure is huge – the biggest in the Round Zodiac. This is in perfect concurrence with our solution, which tells us that there was just one planet visible at dawn on the day of summer solstice – also serving as the brightest star on the celestial sphere. It was Mars, which explains the extraordinary size of Mars in this particular zodiac – it isn't often that Mars plays the part of the brightest star in the sky; a case such as this one is indeed exceptional.

Thus, the correspondence between our solution and the Round Zodiac remains excellent. We draw another plus sign – in the sixth column of the verification table this time.

We have listed all of the secondary horoscopes and are now left with just a few extra scenes and the Passover full moon. However, there are no extra scenes of any substance in the Round zodiac, insofar as astronomical verification is concerned at least. The only item left to consider is the Passover full moon.

Seventh column – the Passover full moon. As we already know, the first vernal full moon would often be drawn in Egyptian zodiacs – the Passover full moon, that is, qv in CHRON3, Chapter 15:9.1.

The first vernal full moon fell on 20 March in 1185 (as calculated with the Turbo-Sky program), which is the very solution date that we came up with for the Round Zodiac. Thus, the Passover full moon simply coincides with the primary date of the horoscope, and is therefore unlikely to be drawn separately.

This appears to be true. There is no separate symbol to stand for the Passover full moon, like the one we encountered in the Long Zodiac, for instance. It has to be remembered that the date of the Long Zodiac's primary horoscope also coincides with a full moon – albeit one that bears no relation to the Passover. It can be found in Libra, in the same position as the Passover full moon. This manifested as the two moons we see in the Long Zodiac – one of them belongs in the primary horoscope, and the other one stands for the Passover full moon. On the contrary, the Round Zodiac that we have under study here only has a single full moon for both the Passover and the main horoscope.

We must point out that since the Round Zodiac contains the date of the Passover full moon, it is de facto an Easter zodiac.

And so we draw our final plus sign in the seventh column of the verification table.

There are no additional scenes anywhere in the Round zodiac that could assist us with astronomical dating. The scenes we do find therein, such as "the wolf on the scythe" and "the severed head next to Aquarius" (qv in CHRON3, Chapter 15:9) play no part in astronomical verification.

Our table is complete and has got a plus sign in its every column, qv in fig. 17.29. The present solution of the Round Zodiac is therefore exhaustive and final.

There were no more complete solutions for any other interpretation of the Round Zodiac.

Corollary:

The Round Zodiac of Dendera contains the following date: morning of 20 March 1185 A.D. The first full moon that spring (the Passover full moon) falls on the same night.

5. THE DECIPHERMENT OF THE DATING CONTAINED IN THE ZODIAC FROM THE GREATER TEMPLE OF ESNA (EB)

Let us now consider the zodiacs from Esna – another ancient Egyptian city, also located near the "Bight of the Kings" on the Nile, likewise Dendera, qv in fig. 17.5 above. Esna is located further up the current of Nile than Dendera and the actual royal necropolis – on the coast of Nile, at the very southern edge of the bight on the Nile.

During the Napoleonic expedition to Egypt, Europeans discovered a number of "extremely ancient" Egyptian constructions in Esna. According to the drawings from the Napoleonic album ([1100]), the constructions were destroyed or seriously damaged.

In particular, they discovered two ancient temples with zodiacs inside them. One of the temples is very large, whereas the other one (in the north of Esna) is a great deal smaller, which is why we're referring to them as to the Greater and the Lesser Temple of Esna.

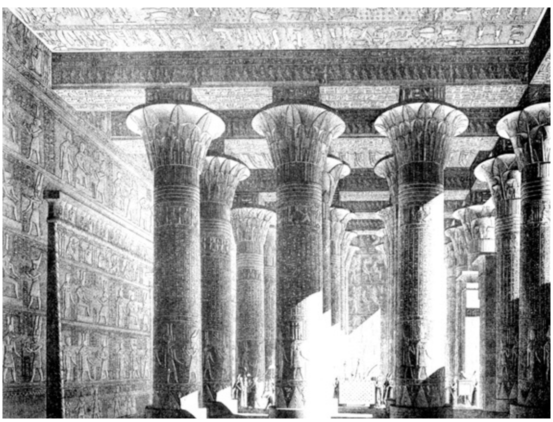


Fig. 17.32. The inside of the Greater Temple in Esna according to the drawing of the Napoleonic artists (reconstruction). In the foreground one sees the ceiling with the zodiac that we shall be referring to as the "Greater Zodiac of Esna", or the EB zodiac. Taken from [1100], A. Vol. I, Pl. 83.

Zodiacs were found in both of the temples. Just like the ones from Dendera, they were gigantic ceiling bas-reliefs carved in stone. We shall witness many similarities between the zodiacs from Dendera and Esna – the astronomical symbolism used therein is uniform for the most part.

A reconstruction of how the Greater Temple of Esna looked on the inside can be seen in fig. 17.32. It was taken from the Napoleonic album ([1100]). One sees the zodiac that we call the Greater Zodiac of Esna, or simply the Greater Zodiac (EB in abbreviation) on the ceiling of the temple. It was copied by Napoleonic artists quite meticulously, and represented in [1100] twice – as a simple drawn copy and a shaded one. The former was cited above in fig. 12.18, and the latter can be seen in fig. 17.33.

After the discoveries concerning the Dendera zodiacs, the question of just which dates we can find transcribed in the zodiacs from Esna is all the more interesting to us, since Esna is rather close to Dendera, as you may remember, and both towns are adjacent to the royal Egyptian necropolis in the "Bight of the Kings".

We shall consider the zodiac from the Lesser Temple of Esna below, and proceed with the interpretation and dating of the Greater Zodiac from Esna.

5.1. Copies of the zodiac from the Greater Temple of Esna

We shall need a more detailed drawn copy for the purposes of dating than the ones found in fig. 12.18 above. Such a copy can be seen in figs. 17.34 – 17.37. The drawings allow the readers to follow each step of the astronomical symbols contained in the Greater Zodiac.

The only copies of the zodiacs from Esna that we had at our disposal come from the Napoleonic album ([1100]). Above, in our analysis of the Dendera zodiacs, we have seen that these copies are prone to containing minor imperfections. They are nevertheless rather accurate, and suffice for dating. It would naturally be expedient to have precise photographs of the Esna zodiacs, like the ones that proved very useful to us in case of the Round Zodiac, qv above. Unfortunately, we had no options of obtaining such photographs.

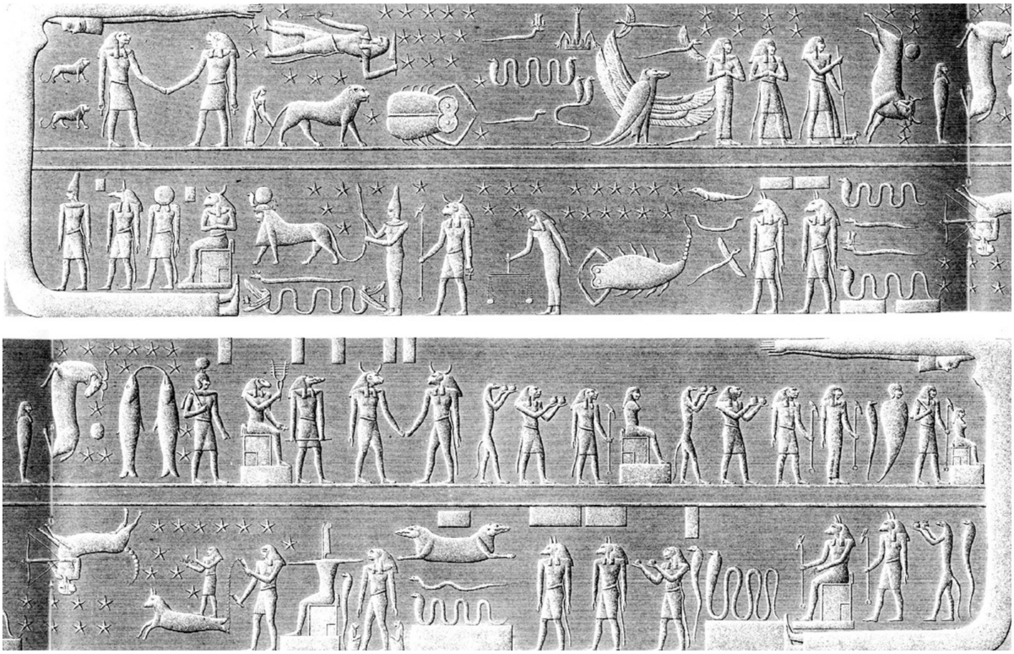


Fig. 17.33. Shaded copy of the Greater Zodiac (EB) from the Napoleonic album. Taken from [1100], A. Vol. 1, Pl. 79.

As above, we shall describe our dating of the Greater Zodiac from Esna step by step, qv in CHRON3, Chapter 16:7.

5.2. Coloured zodiac from the Greater Temple of Esna. Symbols of constellations and planets in the primary horoscope

Step 1, qv in CHRON3, Chapter 16:7.1. The initial interpretation of the primary horoscope and the compilation of the zodiac's "coloured version".

The general tables of Egyptian symbols as seen in CHRON3, Chapter 15:1, make it rather easy to find all the figures of zodiacal constellations in the Greater Zodiac. For the most part, they coincide with the ones used in the zodiacs from Dendera. The only figures that need to be described separately are those of Gemini, Libra and Virgo, which appear to be quite odd in this case.

The constellation of Gemini is represented by three figures and not the usual two, qv in the coloured versions of the zodiacs from Esna. The first of the Gemini figures is a man with a long stick in both hands which he rests upon a small animal under his feet, followed by the two other figures, one male and the other female, whose arms are crossed in the exact same manner. This triad looks perfectly identical in both zodiacs from Esna, standing for the constellation of Gemini in both cases. This is a unique characteristic of the two zodiacs from Esna; this constellation looks differently in other Egyptian zodiacs. See more on this in CHRON3, Chapter 15:1.3.

Libra is simply drawn as a pair of scales, just the same as in the zodiacs of Dendera. We focus our attention on them for the sole reason that the scales are held by a woman in the Greater Zodiac. We believe the female to be part of the secondary winter solstice horoscope, since it is located in the corresponding area – see CHRON3, Chapter 15:1.3 for argumentation in support of this theory. Moreover, it is proven by the exhaustive solution for the Greater Zodiac discovered by the authors. This figure actually stands for Venus in one of the secondary zodiacs; we shall expound this in detail below.

The same can be said about the symbol of Virgo in the Greater zodiac, which is drawn here in the exact

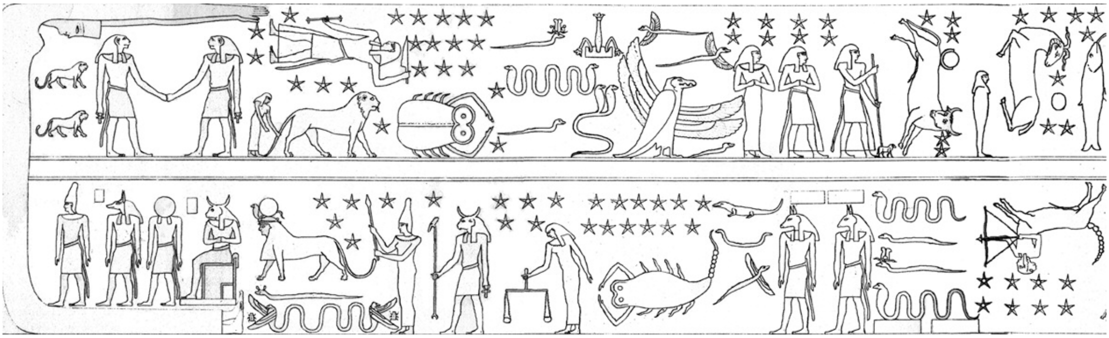


Fig. 17.34-35. A magnified drawn copy of the Greater Zodiac of Esna (EB) from the Napoleonic album. Part one. Taken from [1100], A. Vol. I, Pl. 79.

same way as it is in the zodiacs from Dendera. It is the woman with an ear of wheat in her hands. In fig. C6 the figure is highlighted red; we also see a lioness with a human face, whose tail nearly touches the hands of Virgo; this figure stands apart from the constellation and must belong to the secondary horoscope of autumn equinox from the Greater Zodiac.

The only reason we should mention the figure is that it may be misinterpreted for the constellation of Leo at a glance due to semblance in appearance – this is how we usually see the figure of Leo drawn in Egyptian zodiacs: a woman that either stands on the lion's tail or holds on to it, qv in Chron3, Chapter 15:1.5. However, this assumption would be incorrect, since the real constellation figure of Leo is elsewhere on the Greater Zodiac, whereas the abovementioned lioness with a human face does not form the Egyptian symbol of Leo in conjunction with Virgo. Indeed, let us study them more attentively. First of all, the leonine figure is grossly out of proportion as compared to the Egyptian drawings of Leo. The woman, or the so-called "auxiliary Virgo, is never bigger than the actual constellation figure in any Egyptian zodiac, qv in Chron3, Chapter 15:1.5. One clearly sees the contrary to be the case, since the figure in question is the primary Virgo. Apart from that, the leonine figure with a human face seen next to Virgo is explicitly accompanied by a transposition symbol, since it stands on a snake, qv in Chron3, Chapter 15:6; there is nothing of the kind anywhere near Virgo. This is why we have to ascribe the leonine figure to a secondary horoscope, separating it from the constellation. Finally, the above is also confirmed by our solution.

There are no new characteristics pertaining to constellation figures in the Greater Zodiac of Esna.

The coloured version of the Greater Zodiac, qv in fig. C6, has all of the figures highlighted in red (the colour code is explicated in Chron3, Chapter 16:8).

Now for the planets of the Greater Zodiac's primary horoscope. There are no particular complications involved so far – most of the primary horoscope's planets can be identified effortlessly, some of them at the first sight.

We recognize Saturn instantly – it is in Virgo, near the edge of the Zodiacal strip, qv in fig. 17.34, and looks just the same as it does in the zodiacs of Dendera – a wayfarer with a crescent on his head.

Furthermore, one must pay attention to the fact that all the figures carrying planetary rods are grouped into five groups on the zodiac, according to the number of planets drawn in Egyptian zodiacs (with the exception of the Sun and the Moon). Three of the groups have a single planetary figure with a rod each, whereas the other two have a pair each, one figure following in steps of the other (see fig. C6, where all of these figures are highlighted yellow.

This circumstance happens to be the key to the solution of the entire horoscope. The ancient concept of Mercury and Venus possessing a "double nature" is already known to us quite well – after all, the two have smaller orbits than the Earth, and are always close to the Sun as seen by a telluric observer. They hide behind the Sun every now and then, and appear

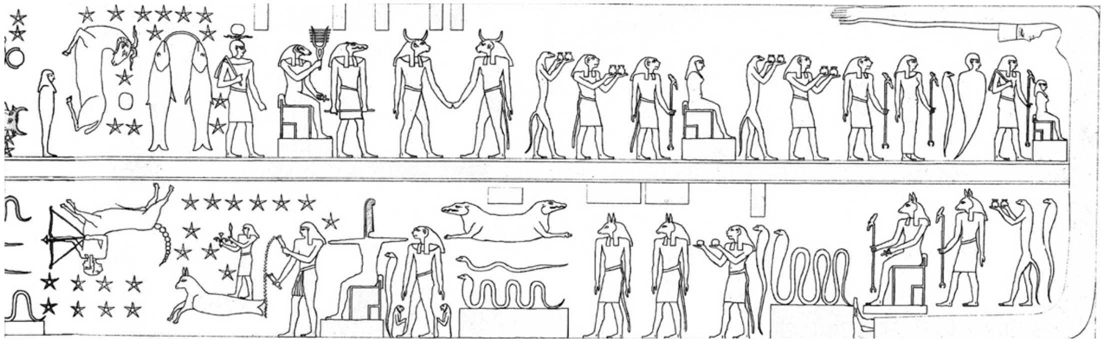


Fig. 17.36-37. A magnified drawn copy of the Greater Zodiac of Esna (EB) from the Napoleonic album. Part two. Taken from [1100], A. Vol. I, Pl. 79.

from a different side of the luminary every time, hence their attribute of matutinal and vespertine visibility. See more on it above, in CHRON3, Chapter 15:4.

Indeed, we recognize a woman in one of the double figures carrying planetary rods. It is accompanied by a man with the head of a lion, qv in fig. 17.37. We see no other female figures equipped with planetary rods anywhere else in the Greater Zodiac, which makes it easy for us to recognize this planet as Venus. We see two other female figures sitting on stools close nearby, the left one being bigger and the right one smaller. We shall learn what they stand for soon enough – for the meantime, let us simply point out their female gender; all the other similar figures sitting upon stools that we encounter in the Greater Zodiac are male, which is yet another indication that the planet we see here is Venus – a female planet.

The second couple of rod-bearing figures that we found grouped together is drawn as two male figures with heads of either jackals or dogs. The planet they represent is therefore Mercury; we see that one of its "representatives" holds a planetary rod whilst sitting on a chair. The other one is close nearby; both figures are located at the very edge of the zodiacal strip, qv in fig. 17.37.

Furthermore, we see a whole collection of attributes pertaining to "double planets" between the two figures; these can only relate to Venus and Mercury. Then there are some explicitly Mercurian attributes to boot – primo, two figures, identical in both appearance and pose, secundo, a bicephalous animal, tertio, two small animals of a kind looking at each other, and quatro, prostrate arms of the figure sitting on the chair. Finally, the figure's head is replaced by a feather, which is another symbol of Mercury, qv in CHRON3, Chapter 15:4.10.

All of the above means that Mercury was either in Aquarius, or close nearby.

The other two planets of the primary horoscope are less conspicuous. One of the figures looks like a man holding a planetary rod in his hand and a whip on his shoulder, which we see to the right from Venus (near the edge of the zodiacal strip) and the man with a leonine head who also carries a planetary rod, to the left from the pair of sitting female figures. See fig. 17.37, as well as the coloured version of the Great Zodiac in fig. C6, where the figures are highlighted yellow.

Since we have already identified the two other planets of the primary horoscope (with the exception of Jupiter and Mars), the remaining pair must represent Jupiter and Mars.

We shall refrain from guesswork in establishing their respective identity and consider two versions equally viable at this stage (jumping ahead, we can tell the reader that the figure with the whip proved to be Mars, whereas the wayfarer with a leonine head represents Jupiter).

Furthermore, unlike the zodiacs from Dendera, where the main complications involved the respective identity of the Sun and the Moon, their respective symbols in the present zodiac make it perfectly easy to distinguish between the two. We only see two circles here – one of them is in Taurus and has a very

eloquent crescent drawn inside of it, whereas the second circle (between Aries and Pisces) is plain and simple, without any crescents. The most likely position for the Moon is therefore Taurus, and Aries for the sun. The main solution proves this very well.

Nevertheless, we have considered versions involving the reverse identification of the couple, less probable but possible in theory, where the circle with a crescent in Taurus stands for the Sun with a new moon, whereas the full moon is represented by the simple circle between Aries and Pisces. However, this identification gave us no full solutions, proving itself false ipso facto.

We compiled the coloured version of the Greater Zodiac as a result, qv in fig. C6.

Thus, we managed to identify most of the primary horoscope's figures from the Greater Zodiac already at the stage of preliminary analysis, the only cases with options being those of Mars/Jupiter and Sun/Moon. However, astronomical calculations resolved the ambiguity instantly, since there are very few preliminary solutions of the Greater Zodiac – about ten of them all in all, the exhaustive solution being unique.

The small number of preliminary solutions is understandable in this case. Mark the fact that all the planetary figures of wayfarers one finds in the primary horoscope are located between Pisces and Aquarius, with the sole exception of Saturn. Furthermore, the cusp of the two constellations occupies *one half* of the entire zodiac's space, no less.

We can thus instantly make the conclusion that we see an almost complete planet caravan between Pisces and Aquarius – the only planet we find elsewhere on the date transcribed in the Greater Zodiac is Saturn.

This is very good for astronomical dating, since the dates of the primary horoscope can be calculated without the need of identifying any planet separately, except for Saturn – we already know the rest to be located in either Pisces or Aquarius.

We performed all necessary calculations, but they yielded no other exhaustive solutions, which makes our identification of all planets included in the Greater Zodiac's primary horoscope unequivocal.

The symbolism of the Greater Zodiac of Esna proved to correspond with the zodiacs from Dendera in particular, and other Egyptian zodiacs in general, qv in CHRON3, Chapter 15:1, and CHRON3, Chapter 15:4. In other words, there we discovered no contradictions between the astronomical symbols used in zodiacs found in Dendera, Esna and elsewhere in Egypt. Nevertheless, the zodiacs from Esna possess a number of unique characteristics, which is especially manifest in case of the Lesser Zodiac, as we shall see further on.

We assume the readers to have the coloured version of the Greater Zodiac (fig. C6) at their disposal for necessary reference, as well as the drawn copy thereof, qv in figs. 17.34-17.37.

5.3. The primary horoscope and the "doubles" of planets in the EB zodiac

Planetary figures from the primary horoscope of the Greater Zodiac were discussed in enough detail earlier on. Let us define their distribution across zodiacal constellations.

Saturn is the male figure with a bovine head with a crescent on its head; we see it between the symbols of Virgo and Libra, which means it may have been in either of the two constellations; they shall thus comprise its allowed position area.

The middle of Virgo was chosen as the "best point" for Saturn – simply because there is another figure in Virgo that resembles Saturn – its "sitting double", which is the very same figure, but without the planetary rod and sitting instead of walking.

Despite our choice of the "best point" (middle of Virgo), we find Saturn exactly on the cusp of Virgo and Libra, which is where it should be for the primary figure, unlike its sitting double.

Pay attention to the fact that most of the primary horoscope's planets from the Greater Zodiac of Esna have such "sitting doubles" except for Mars and the Moon. The former has a double nevertheless, although a special one – it looks like a military shield with a human head upon it. The "double of the Moon" shall be described in more detail below; it is the tiny figure between Taurus and Aries. All the "doubles" are highlighted green in the coloured version of the Greater Zodiac, qv in fig. C6. The Sun is the only figure left without a double.

All of these "doubles" are located near the primary figures of their respective planets, possibly standing for secondary horoscopes – however, they should all re-

late to vernal equinox in this case, excepting Saturn (bear in mind that all the other planetary figures are concentrated between Pisces and Aquarius). However, the date of the vernal equinox shall be close to that of the primary horoscope. After all, the primary horoscope's solar figure is drawn in Aries, right next to Pisces – the constellation housing the spring equinox point of the primary horoscope, qv in CHRON3, Chapter 15:8.3. This implies the possibility that the doubles do actually stand for planets from secondary horoscope, and their positions on the zodiac must indeed be close to the figures of the primary horoscope.

However, in this situation they offer no help in the elimination of extraneous solution since the disposition of such "doubles" gives us no new information to complement the primary horoscope; furthermore, we cannot even be certain that the figures come from a secondary horoscope and don't merely accompany the primary horoscope's planets as entourage.

We already mentioned Saturn, and will proceed with the rest of the primary horoscope's planets found in the Greater Zodiac of Esna.

Mercury, Jupiter, Venus and Mars are all shown between Aquarius and Pisces, which limits the acceptable position area of all four planets to these two constellations. Also, in accordance to what we said in the previous section, the only acceptable order options for these planets on the ecliptic counting from Aquarius to Pisces are as follows:

Mercury – Mars – Venus – Jupiter,

or

Mercury – Jupiter – Venus – Mars.

Finally, let us consider the Sun and the Moon.

We find the Sun between Pisces and Taurus; said constellations will therefore comprise its acceptable position area.

We see the Moon on the back of Taurus. It is therefore either in this constellation or in Aries, since the lunar circle is drawn in between the two; the acceptable position area for the Moon must therefore cover both Aries and Taurus.

We also have a reverse interpretation option, with the Sun and the Moon swapping positions, qv in the previous section.

Let us however point out that in the final solution the Sun is on the cusp of Aries and Taurus, whereas the Moon is right in Taurus, qv below.

5.4. Visibility indicators in the EB zodiac

Indicators of planetary visibility as used in the Greater Zodiac of Esna are substantially different from the ones from the Dendera zodiacs. The latter used a star over the head of a planetary figure to indicate its visibility, which isn't drawn if the planet was invisible.

Au contraire, we see no symbols to indicate that a planet was visible; however, invisible planets have solar circles instead of heads, which is perfectly correct astronomically – it is the solar radiance that renders planets invisible, after all. The Sun stands between the observer and the planet, obscuring view; we therefore see a solar circle instead of the planet's face.

Each planet in the primary horoscope of the Greater Zodiac from Esna is drawn visible, with just a few planets from the secondary horoscope of autumn equinox possessing invisibility indicators. See more about this below.

5.5. Secondary horoscopes in the EB zodiac

Secondary horoscope of autumn equinox in Virgo. We see the following figures in the respective part of the Greater Zodiacs, which either stand for planets in a horoscope, or serve as additional astronomical symbols that must get some sort of explanation in the exhaustive solution.

On the left of Virgo we see a lioness with a human face with a large circle on her head. As we explained above, this figure bears no relation to the constellation of Virgo and therefore comes from a secondary horoscope, which is also emphasized by the autumn equinox sign that looks like a two-headed snake below. See CHRON3, Chapter 15:8.1 for more details on the autumn equinox symbols used in Egyptian zodiacs.

The lioness usually symbolises Venus in Egyptian zodiacs, which must also be the case here, qv in CHRON3, Chapter 15:4.8.

The other female figure (the one that holds the scales of Libra and also stands for Venus from a secondary horoscope - the only planet of the feminine gender, as you remember, must relate to the secondary horoscope of winter solstice. The area to the right of Virgo, after Libra, must therefore contain planets

from another secondary horoscope, and our search should be continued in the opposite direction – towards Leo.

After the leonine Venus we see Saturn, which makes perfect sense. The primary horoscope's Saturn is either in Libra or Virgo, and so we must find this rather slowly-moving planet close nearby on the day of the autumn equinox as well.

Saturn is followed by a triad of figures, one of which has a solar disc instead of a head, signifying its invisibility in solar rays. The two others should stand for planets that were visible that day; all planets are represented with male figures.

The route of our further movement across the Greater Zodiac turns around the curved body of the "goddess Nuit" and changes direction, making us proceed from left to right. The first thing we see here is the autumn equinox symbol that looks like two male figures with leonine heads holding hands. See Chron3, Chapter 15:8.1 and Chron3, Chapter 15:8.3 for more on equinox symbols in Egyptian zodiacs. We are therefore still in the territory of the autumn equinox horoscope.

Next we see a symbol of Leo with an "auxiliary Virgo" over its tail. There is a figure of a militant-looking man above, who has raised a large knife or a sword over his head as if he were trying to kill someone – most likely Mars or Saturn. We see it above Leo and the "auxiliary Virgo", which locates the planet in either Leo or Virgo. It is however possible that the figure comes from the secondary horoscope of summer solstice, since we find it at the border of two secondary horoscope.

This is where the area of the autumn equinox ends; it is followed by the sign of Cancer, and, further on, a collection of summer solstice symbols, qv in Chron3, Chapter 15:8.4.

We came up with the following secondary horoscope.

Venus was in Virgo on the day of the autumn equinox – possibly invisible, judging by the solar circle on its head. There were three more planets in Virgo apart from Venus, one of them invisible and the other two visible. Further on we find Leo and Virgo; one of the constellation housed Mars (or, possibly Saturn; if not, we expect it to be there on the day of summer solstice).

Secondary horoscope of winter solstice in Sagittarius. This is where the sign of Sagittarius represents a standard astronomical hieroglyph with a minimal secondary horoscope. It marks the point of winter solstice, without providing us with any further information of any substance.

Nearby, in Capricorn, we find a small male figure holding the solstice symbol in its hand. We mentioned it above, in Chron3, Chapter 15:8.2, when we were discussing the symbolism of the equinox points. This object is a symbol of the winter equinox and not a planet.

To the left from the Sagittarian sign we shall first see a collection of solstice symbols looking as snakes of different kinds, qv in Chron3, Chapter 15:8.2. Next to them there are two absolutely identical male figures with jackal heads. The only planet that could be drawn in this manner is Mercury – a "double" male planet, qv in Chron3, Chapter 15:4, where we mention the fact that a jackal's head symbolises Mercury in Egyptian zodiacs.

Next, right after Scorpio, we see a female figure holding the pair of scales that symbolises Libra in her hand. We mentioned it above and discovered that it must pertain to the secondary horoscope of winter solstice. Thus, Venus was in Libra on solstice day.

We came up with the following secondary horoscope of winter solstice: Mercury is in either Sagittarius or Scorpio, and Venus is in Libra.

Let us move on to the next secondary horoscope.

The secondary horoscope of spring equinox in Pisces. This horoscope is absent. The possible reason may be extreme proximity to the primary horoscope.

Alternatively, it may be represented by the "sitting doubles" – however, this shall hardly help us with verifying solutions, since the "doubles" are but a reflection of the primary horoscope, which is satisfied in all of our preliminary solutions at any rate. In other words, all the preliminary solutions shall conform to such a horoscope automatically.

The secondary horoscope of summer solstice in Gemini. We see this horoscope to be all but empty in the Greater Zodiac of Esna. The actual figure of Gemini is drawn in the usual manner – as an "astronomical hieroglyph" that incorporates the actual constellation sign as well as a minimal secondary horoscope (Venus and Mercury), represented by the female and

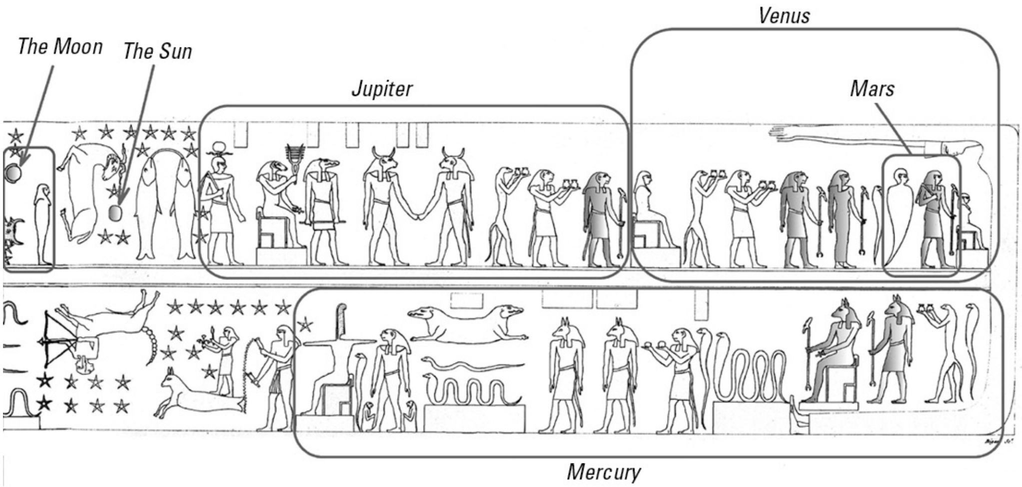


Fig. 17.38. The final interpretation option for the Greater Zodiac of Esna (EB) that led us to the exhaustive solution. Planetary figures relating to each planet in the primary horoscope are highlighted, whereas the central drawings of planets as wayfarers with rods are shaded. Drawing made in accordance with the drawn copy from [1100], A. Vol. I., Pl. 79.

male figure of Gemini, respectively, qv in CHRON3, Chapter 15:8.4. In the zodiacs from Esna, the "astronomical hieroglyph" of Gemini differs from those we encounter in other Egyptian zodiacs to some extent, qv in CHRON3, Chapter 15:8.4.

To the left from Gemini we see a large number of summer solstice symbols, qv in CHRON3, Chapter 15:8.4 – in between Gemini and the neighbouring constellation of Cancer, qv in fig. C6. However, there is only one symbol that could stand for a planet in this secondary horoscope, namely, the bicephalous snake between Gemini and Cancer.

As we should remember, the militant-looking figure of either Mars or Saturn over Virgo and Leo may also be part of this horoscope, but only given that it isn't involved in the autumn equinox horoscope.

5.6. The exhaustive solution of the EB zodiac: 31 March – 3 April 1394 A.D.

There is just a single exhaustive solution for the Greater Zodiac of Esna, namely, 31 March – 3 April 1394 A.D.

Source data for the Horos program as used in our search are given in Annex 4.

In fig. 17.38 one sees the final interpretation of the Greater Zodiac that yielded the exhaustive solution; it turned out that the planets of the primary horoscope are represented in the zodiac by the following symbols.

The Sun as a circle in Aries. According to our solution, the Sun had been at the cusp of Aries and Taurus, transcending from the former into the latter.

The Moon as the circle with a crescent inside it as seen on the back of Taurus. The Moon was passing through Aries and Taurus in our solution; however, it immediately became invisible in Aries. Finally, a new moon appeared in Taurus on 3 April 1394, right in the stellar agglomeration known as the Pleiades. It had enjoyed a great deal of attention in mediaeval astronomy due to its excellent visibility on the celestial sphere. According to the calculations performed with the aid of the Turbo-Sky software, the Moon remained invisible throughout the entire period between 31 March and the evening of 3 April, making its first appearance as the narrow crescent of the new moon in Pleiades (and Taurus), qv in fig. 17.39.

It becomes clear why we should see a tiny female figure looking like an upright Egyptian sarcophagus of the anthropomorphic type. This figure is highlighted green in the coloured version of the zodiac. Let us remind the reader that such figures represented

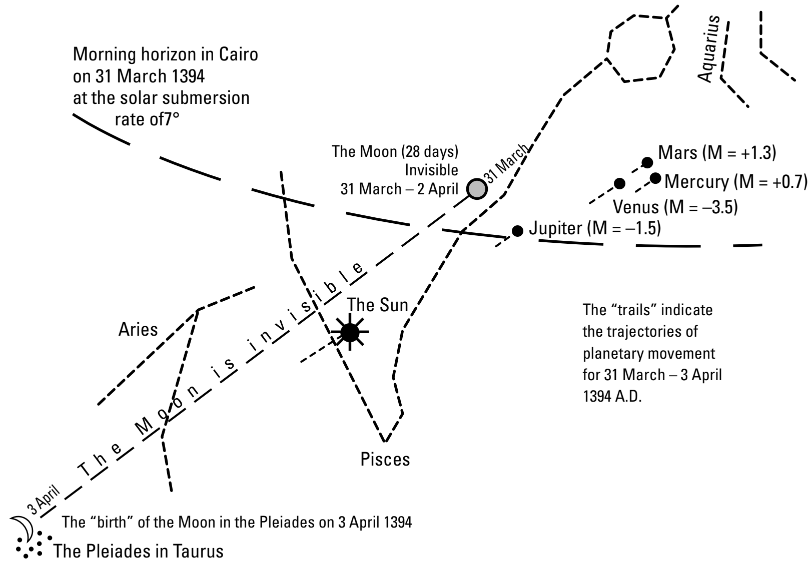


Fig. 17.39. The exhaustive solution of the Greater Zodiac from Esna. Jupiter, Venus, Mars and Mercury are in Pisces on 31 March – 3 April 1394 A.D. On 31 March, the first day of the solution, Jupiter rose in Cairo at the solar submersion rate of 7 degrees (8 degrees for Luxor), which made it visible at dawn, considering the luminosity M = –1.5. On 3 April Jupiter would rise at the solar submersion rate of 8.5 degrees in Cairo and 10 degrees in Luxor, which made its visibility even better. Venus, Mars and Mercury rose at the minimal solar submersion rate of 14 degrees those days, which means near-total darkness. They had been visible well at dawn and before sunrise on the preceding days. Mars and Mercury proved to be at the same ecliptic longitude. The Moon was invisible starting 31 March due to the New Moon. It had first appeared in the evening of 3 April as a narrow young crescent in the Pleiades (Taurus). The "trails" correspond to the shifting positions of the Sun and the planets over the 4 days between 31 March and 3 April 1394. Calculated in Turbo-Sky. The drawing is approximated.

dead people in Egyptian symbolism; they would also often be drawn standing up, which may have symbolised the ensuing resurrection, qv in CHRON3, Chapter 15:9.1. Indeed, the moon "dies" to "resurrect" in two days.

The sarcophagus figure also serves as the double of the Moon in the Greater Zodiac. As this is an Egyptian sarcophagus, it naturally cannot remain in a sitting position, the way it is with the doubles of other planets. The sarcophagus "double" of the Moon corresponds very well to the latter having been "dead", or invisible, on the days covered by the horoscope, reappearing in Taurus as a narrow crescent of the new moon as late as the 3 April 1394 – the last day of our solution.

Let us consider all the other planets now.

Saturn was located at the very cusp of Virgo and Libra in our solution, corresponding to the position of Saturn in the Greater Zodiac precisely. The planetary figure of Saturn has the appearance of a wayfarer with a staff and a crescent on its head, and we find it right in between Virgo and Libra, qv in the coloured version of the Greater Zodiac.

Furthermore, Jupiter, Mercury, Mars and Venus congregated in the middle of Pisces, which is just where we find them in the Greater Zodiac of Esna. The planets were very close to each other, the maximal distance between them equalling 10 degrees. Venus, Mars and Mercury have all been at the distance of 2-3 degrees from each other. The disposition of these four planets for the days covered in our solution can be seen in fig. 17.39.

Jupiter only attained matutinal visibility on 31 March; it rose when the Sun had set by 7 degrees in Cairo and 8 degrees in Luxor. Previously it would rise at insufficient solar submersion rates, rendered invisible by this circumstance. Jupiter (M = –1.5) would approximately equal Sirius in luminosity; this

would guarantee its visibility for the solar submersion rate of 7-8 degrees ([393], page 16). See CHRON3, Chapter 16:7.3 for details on visibility conditions. On the last day included in our solution, 3 April 1394, Jupiter would rise when the solar submersion rate equalled 8.5 degrees in Cairo and 10 degrees in Luxor, which made its visibility even better – however, one could only observe the planet at very early dawn.

This might be the reason why we see a man with a circle on his head in the Greater Zodiac of Esna; it is highlighted green in the zodiac's colour version. The circle on the figure's head is large enough, which might refer to the proximity between Jupiter and the Sun – as though the former was carrying the latter on its head.

At the same time, the general headdress pattern of this man that resembles a circle between the horns, is the same as we see on Jupiter from the zodiacs of Dendera – we mentioned this in CHRON3, Chapter 15:4.6. This is another indirect confirmation of the fact that we identified Jupiter correctly in the Greater Zodiac. However, we must reiterate that this identification is purely formal and conforms to the complete solution. In the preliminary stage we also considered the possibility of identifying this figure as Mars.

The next after Jupiter (counting from the Sun) is Venus, followed by Mars and Mercury, qv in fig. 17.39. Venus had been behind Mercury and Mars, qv in fig. 17.39. In the previous days Venus had been behind Mercury and Mars, taking over them on 25 March. This may explain the fact that Mars is enclosed between two "sitting doubles" of Venus in the Greater Zodiac entirely – one of them large, just like the ones that other planets have got, and the other small, qv in fig. 17.38. These "doubles" appear to be marking the route of Venus past Mars. The small double indicates the past position of Venus, when it had been on the other side of Mars, whereas the large one corresponds to the correct position of Venus in relation to other planets on the dates included in the primary horoscope, qv in the coloured version of the Greater Zodiac, where all of the planetary "doubles" are highlighted in green.

Mars and Mercury remained at virtually the same longitude between 31 March and 3 April 1394 – quite close to each other on the ecliptic, that is. Their respective order in the zodiac could therefore be indicated in any which way; it happens to be as follows: Jupiter, Venus, Mars and Mercury, qv in fig. 17.38.

Venus, Mars and Mercury rose at the solar submersion rate of 14 degrees at least – in almost complete darkness, in other words. All of them were visible very clearly before sunrise and at dawn on the days included in our solutions, as well as the ones preceding them.

Furthermore, a week before the beginning of the primary horoscope's interval, on 25 March 1394, all of the three planets (Venus, Mars and Mercury) got so close to each other that they could be observed as a single luminous dot in the sky. The distance between Mercury and both Mars and Venus equalled a mere 5 arc minutes. The luminosity of Venus equalled –3.5 on the photometric scale, the respective values for Mercury and Mars are +0.7 and +1.3. Such great luminosity (especially in case of Venus) and close propinquity between the planets would transform all three into a single star of exceptional brightness as observed by the naked eye.

The event must have been very spectacular; it could be observed in Cairo before sunrise and at dawn on 25 March, 1394. The submersion rate of the Sun when this "triple star" rose had equalled 14 degrees, and so it was still dark. In fig. 17.40 one sees the respective disposition of the Sun, Mercury, Mars and Venus on 25 March 1394 – before sunrise, as observed from Cairo when the submersion rate of the Sun equalled 10 degrees.

It has to be said that the primary horoscope of the Greater Zodiac from Esna was compiled from planetary positions that could be observed immediately after this magnificent event. Solution days begin right after the conjunction of the three planets, when Jupiter appeared in the sky followed by the "birth" of the Moon. This happened a week after the triple conjunction – Jupiter became visible on 31 March, and the Moon on 3 April. This is precisely the solution we came up with for the Greater Zodiac.

Let us conclude by citing calculated planetary positions for 31 March – 3 April 1394 A.D. The dates are given according to the Julian calendar (year/month/date) and in Julian days as used in astronomical calculations ([393], page 316); see also CHRON3, Chapter 16:4.

Planetary positions are given in degrees on ecliptic J2000 (first line) and the "constellation scale" (second line). The third line contains the name of the constellation that the planet in question ended up in; see CHRON3, Chapter 16:4 for more details.

The astronomical new moon fell on 31 March – 2 April 1394, which means the Moon hadn't been visible in the sky and only appeared in Taurus first, right next to the Pleiades in the evening of 3 April (as calculated in Turbo-Sky).

THE EXHAUSTIVE SOLUTION FOR THE GREATER ZODIAC FROM ESNA (PRIMARY HOROSCOPE)

Julian day (JD) = 2230306.00 <the "death" of the Moon>
Year/month/day = 1394/3/31

Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
27.2	378.6	214.8	373.6	359.7	362.8	359.8 (longitude)
0.02	11.80	5.98	11.68	11.33	11.41	11.33
Ari/Pisc	Pisces	Vir/Lib	Pisces	Pisces	Pisces	Pisces

Average deviation from "best points" equals 14 degrees.

Julian day (JD) = 2230307.00 <the Moon is invisible>
Year/month/day = 1394/4/1

Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
28.1	31.7	214.7	373.8	360.5	364.0	360.8 (longitude)
0.06	0.21	5.98	11.68	11.35	11.44	11.36
Ari/Pisc	Aries	Vir/Lib	Pisces	Pisces	Pisces	Pisces

Average deviation from "best points" equals 13 degrees.

Julian day (JD) = 2230308.00 <the Moon is invisible>
Year/month/day = 1394/4/2

Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
29.1	44.6	214.7	374.0	361.2	365.2	361.8 (longitude)
0.10	0.72	5.98	11.69	11.37	11.47	11.38
Aries	Aries	Vir/Lib	Pisces	Pisces	Pisces	Pisces

Average deviation from "best points" equals 11.5 degrees.

Julian day (JD) = 2230309.00 <the Moon is "born" in Taurus>
Year/month/day = 1394/4/3

Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
30.1	57.3	214.6	374.3	362.0	366.4	362.8 (longitude)
0.14	1.15	5.98	11.69	11.39	11.50	11.41
Aries	Taurus	Vir/Lib	Pisces	Pisces	Pisces	Pisces

Average deviation from "best points" equals 11 degrees.

The date of the best correspondence with the Greater Zodiac of Esna is 3 April 1394, when the new Moon was born in Taurus, right over the Pleiades. We see in right over the back of the constellation figure of Taurus in the Greater Zodiac. On 3 April the average "best point" deviation equalled a mere 11 degrees – roughly one third of an average constellation's length on the ecliptic. Remember that the average "best point" deviation of circa 15 degrees (half of constellation) already implies a good correspondence between the planetary positions on the celestial sphere and the figures from the zodiac.

5.7. The verification table for the complete solution of the EB zodiac

Let us cite the verification results for the exhaustive solution of the Greater Zodiac from Esna that we came up with (31 March – 3 April 1394) using secondary horoscopes and planetary visibility indicators. The verification table for the solution can be seen in fig. 17.41; it will demonstrate the degree of correlation between our solution and the Greater Zodiac of Esna, according to auxiliary astronomical information that isn't included in the primary zodiac. Let us remind the reader that under a complete, or exhaustive solution we understand one that has a plus sign in every column of the verification table, which implies perfect correspondence with the Egyptian zodiac in every which way, qv in CHRON3, Chapter 16:14.

The first column corresponds to the visibility of Jupiter. Planetary visibility is a factor of paramount importance in this case, since all of the planets are very close to the Sun. Jupiter must be visible, because the corresponding figure's head isn't replaced by a circle, which would indicate the contrary, qv above.

Indeed, Jupiter's visibility was very good in our solution, as we mentioned above. Let us briefly recollect the visibility conditions for Jupiter between 31 March and 3 April 1394 in Cairo and in Luxor.

On 31 March Jupiter rose in Cairo when the Sun had set by 7 degrees (8 degrees in Luxor). Its luminosity equalled that of Sirius, namely, –1.5, which means it could already be visible with the Sun set by 7-8 degrees (see [393], page 16). This was the day Jupiter appeared in the morning sky for the first time. Before it would rise at lower solar submersion rates.

On 3 April Jupiter rose in Cairo when the solar submersion rate had equalled 8.5 degrees (10 degrees in Luxor) – almost complete darkness, that is, and therefore it was visible even better.

We shall therefore draw a plus sign in the first column of the verification table.

The second column indicates that Venus should be visible according to the Greater Zodiac. In our solution it was indeed visible perfectly – before sunrise and at dawn. On 31 March Venus rose in Cairo when the Sun had set by 13 degrees – in complete darkness, that is. The planet's luminosity had equalled –3.5, and kept getting better. We must therefore put a plus sign in the second column of the verification table as well.

The third column contains data concerning the visibility of Mars and Mercury. These planets were very close to each other in our solution, and therefore their visibility or invisibility should be synchronous. The Greater Zodiac implies that both planets were visible.

Indeed, in our solution both planets were visible very clearly before sunrise and at dawn. On 31 March they rose in Cairo with the Sun set by 14 degrees – in utter darkness, that is. Photometric table luminosity equalled +0.7 for Mercury and +1.3 for Mars. On the following days included in our solution the visibility conditions for Mars and Mercury were even better. We shall therefore draw a plus sign in the third column of the verification table as well.

The fourth column contains the secondary horoscope of autumn equinox.

As above, we shall choose the September year that corresponds to our solution – the one that began in September 1393 A.D. and ended in August 1394 A.D. Autumn equinox day fell on 10 September 1393 A.D., qv in Annex 5. However, in that epoch the solstice

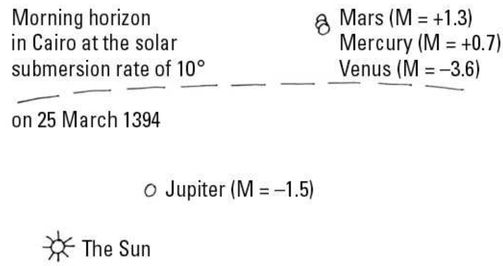


Fig. 17.40. Precise conjunction of Mercury (M = +0.7), Mars (M = +1.3) and Venus (M = –3.6) in the morning of 25 March 1394 before dawn, as observed from Cairo. The distance between Mercury and Mars as well as Mercury and Venus equalled approximately 5 arc minutes, which means that all three planets looked like a single star of incredible luminosity when observed with the naked eye. We see the morning horizon of Cairo at the solar submersion rate of 10 degrees. Calculated in Turbo-Sky. The drawing is approximated.

and equinox days could not be estimated with precision; discrepancies of 5 or 6 days were very common, qv above.

Let us cite the planetary positions on the ecliptic for 9 September 1393. The first row of numeric values found under the names of the planets refers to degrees on the J2000 ecliptic, whereas the second row contains the position of a planet on the "constellation scale", qv in CHRON3, Chapter 16:10.

Julian day (JD) = 2230104.00
Year/month/date = 1393/9/10

Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
184.3	230.9	205.5	349.4	207.9	185.0	184.3
5.24	6.73	5.76	11.07	5.81	5.25	5.24
Virgo	Libra	Virgo	Pisc/Aqua	Virgo	Virgo	Virgo

The celestial sphere as observed from Cairo on the date in question can be seen in fig. 17.42. In the drawing we see the local evening horizon of Cairo at the solar submersion rate of 10 degrees, when most of the stars were already visible, as well as the matutinal horizon in Cairo with the solar submersion rate equalling just one degree, right before sunrise, when both Venus and Mercury had still remained below the horizon – the latter rose simultaneously with the Sun, and the former even later.

The Greater Zodiac of Esna (EB). Verification sheet for the solution of 31 March – 3 April 1394 A. D.

Visibility of Jupiter	Visibility of Venus	Visibility of Mercury and Mars	Autumn equinox	Winter solstice	Spring equinox	Summer solstice	Additional scenes	*Notes*
			S E P T	E M B	E R	Y E A R		
Jupiter rising in Cairo on 31.03.1394. S. S. = 7°. M = -1.5. Could be visible. 3.04.1394. S. S. = 8.5°. M = -1.5. *Visible.* In Luxor. 31.03.1394. S. S. = 8°. M = -1.5. *Visible.* 3.04.1394. S. S. = 10°. M = -1.5. *Visible.* ⊕	Venus rising in Cairo. 31.03.1394. S. S. = 13°, M = -3.5. *Visible during the entire period.* ⊕	Mercury rising in Cairo. 31.03.1394. S. S. = 14°, M = -0.7. *Visible on all days.* Mars rising in Cairo. 31.03.1394. S. S. = 14°, M = +1.3. *Visible on all days.* ⊕	10.09.1393. Sun in Virgo. Venus in Virgo rises after the Sun and sets before it. *Invisible.* Mercury is right next to the Sun and therefore invisible (at a distance of circa 2°). Saturn and Mars in Virgo, rather close to each other (the distance between the two roughly equalling 2°). S. S. = 14°. In vespertine visibility. Jupiter in Pisces (11.1). ⊕	10.12.1393. Sun in Sagittarius. Venus in Libra. *Visible.* Mercury in Scorpio. S. S. = 20°. M = +0.5. *Visible.* Mars in Sagittarius, next to the Sun (at the distance of circa 2°). *Invisible.* Jupiter at the cusp of Aquarius and Pisces (11.1) – at a great distance. ⊕	12.03.1394. Sun in Pisces. Venus in Aquarius (10.6). *Visible.* Mars in Aquarius (10.9). *Visible.* Mercury in Pisces (11.2). *Visible.* Jupiter next to the Sun (at the distance of circa 2°). *Invisible.* ⊕	11.06.1394. Sun in Gemini. Venus at the cusp of Gemini and Taurus. S. S. = 5°. M = -3.4. *Invisible.* Mercury at the cusp of Gemini and Taurus (3.14). S. S. = 19°. M = +0.6. *Visible.* Mars at the cusp of Aries and Taurus (1.05) – already far enough. Jupiter at the cusp of Pisces and Aries (0.07). ⊕	*None.*	Interpretation code EB1. The astronomical Passover full moon falls on 18 March 1394 (in Virgo). Calculated in Turbo-Sky. The Passover Full Moon falls on the 18 April according to the Paschalia. The Easter falls on 19 April 1394 according to the Paschalia.

$\varnothing_{ref} = 11°$

+	+	+	+	+	+	+

Fig. 17.41. The verification table for the complete solution of the Greater Zodiac from Esna – 31 March / 3 April 1394 A.D. Abbreviations used: S. S. – solar submersion rate transcribed in arc degrees (see CHRON3, Chapter 16:7, Step 3-B); M – planetary luminosity; a fraction between 0 and 12 in parentheses is the calculated position of a planet on the "constellation scale", qv in CHRON3, Chapter 16:10. Bottom right – the result of comparing the solution with the zodiac as well as the average distance between planets and their "best points", qv in CHRON3, Chapter 16:11 and 16:14.

Mercury and Venus were therefore rendered perfectly invisible, being lost in rays of sunshine. Venus would rise later than the Sun, already in broad daylight, and set before dusk. Mercury was at a distance of 2 degrees from the Sun and hence also invisible.

The following planets were visible next to the Sun on the day of the autumn equinox in their vespertine phase:

Saturn (M = +1.0) was between Virgo and Libra in the primary horoscope, and would set at the solar submersion rate of 14 degrees – in complete darkness, that is. The luminosity of Saturn equalled that of the brightest stars, which made the planet visible perfectly well at dawn and after dusk.

Mars (M = +1.8) was at the distance of a mere 2 degrees from Saturn. Its luminosity had been somewhat lower than Saturn's, but would still equal that of the brightest stars (1st/2nd order of magnitude). Mars was therefore visible perfectly well next to Saturn at dusk and some time after sunset in Cairo. It was located at the cusp of Virgo and Libra, likewise Saturn.

Moon was three days of age and in Libra.

There were no other planets anywhere near. Jupiter had been at the cusp of Pisces and Aquarius, almost opposing the Sun on the ecliptic. Other planets have already been listed, qv in fig. 17.42.

The result is that we find Venus and three other planets in Virgo, right next to the Sun, on the autumn equinox day of the September year that we came up with in our solution. One of the three is the invisible Mercury; the two others (Saturn and Mars) were visible very well, unlike Venus. The Moon was in the neighbouring constellation of Libra. There were no other planets anywhere near, qv in fig. 17.42.

This is in perfect correspondence with the secondary horoscope of autumn equinox found in the Greater Zodiac. Let us briefly recollect it.

On the day of autumn equinox Venus was in Virgo – possibly invisible (see the solar circle over the figure's head). There were three other planets in Virgo, one of them invisible. Mars or Saturn should have been in Virgo or Leo.

The correspondence is perfect; the only seeming discrepancy one can point out is the absence of the Moon from this secondary horoscope of the Greater Zodiac, despite its nearby location in the solution (the neighbouring constellation of Libra).

However, if we're to study the Greater Zodiac of Esna more attentively, we shall notice the fact that lunar symbolism is absent from every single secondary horoscope that we find there. Apparently, this particular zodiac contains no lunar symbolism in any of its secondary horoscopes, which is actually characteristic for Egyptian zodiacs in general. It is only in the Long Zodiac of Dendera, which is extremely detailed and voluminous, that we find the Moon present in secondary horoscopes.

Bearing this in mind, we see absolute concurrence between the astronomical disposition for the autumn equinox day as suggested in our solution and the secondary horoscope of autumn equinox in the Greater Zodiac. We must therefore draw a plus in the fourth column of the verification table as well.

The fifth column represents the secondary horoscope of winter solstice.

Winter solstice of the September year that we have under consideration fell on 10 December 1393, qv in Annex 5.

Planetary positions on the ecliptic for 10 December 1393 shall be cited below. As above, we cite planetary longitudes in degrees on the J2000 ecliptic as well as planetary positions according to the "constellation scale", qv in CHRON3, Chapter 16:10.

Julian day (JD) = 2230195.00
Year/month/date = 1393/12/10

Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
275.7	359.1	215.5	349.7	273.3	229.9	254.7
8.26	11.31	6.00	11.08	8.19	6.68	7.60
Sagitt	Aquarius	Vir/Lib	Aqua/Pisc	Sagitt	Libra	Scorpio

The Sun was in Sagittarius, with the following planets nearby (qv in fig. 17.43).

Mars was in Sagittarius, albeit invisible. It was at the distance of a mere 2 degrees from the Sun, and therefore impossible to see.

Mercury was in the neighbouring constellation of Scorpio. It was visible quite well, equalling the brightest stars in luminosity (+0.5). Solar submersion rate for the moment Mercury rose in Cairo had equalled 20 degrees – absolute darkness, in other words.

Venus was in Libra – even further away from the Sun than Mercury, at the very edge of the area cov-

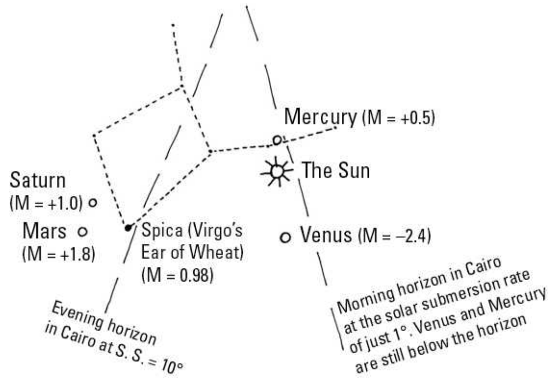


Fig. 17.42. Dislocation of planets in the solar vicinity for 10 September 1393, the day of the autumn equinox. One sees the morning and evening horizon as observed from Cairo. Saturn and Mars were visible next to each other at dusk. Venus and Mercury were perfectly invisible. Calculated in Turbo-Sky. The drawing is approximated.

ered by the secondary horoscope of winter solstice, qv in fig. 17.43. Its luminosity equalled –4.4 on the photometric scale, which is close enough to the possible maximum. Venus must have looked most spectacular during those days.

Jupiter and Saturn were far away from Sagittarius and very close to their respective positions in the primary horoscope, the former being on the cusp of Aquarius and Pisces, and the latter right in between Virgo and Libra.

Let us now compare the calculated astronomical disposition with what one sees in the winter solstice horoscope of the Greater Zodiac. We may recollect this horoscope to have Mercury in either Sagittarius or Scorpio, and Venus in Libra.

The correspondence is good enough. The only planet found near the Sun that remained without representation is Mars; however, it had been invisible during the winter solstice period. As we know, invisible planets would often be omitted from secondary horoscopes. This is why we draw a plus sign in the fifth column of the verification table as well.

The sixth column corresponds to the secondary horoscope of spring equinox.

Spring equinox fell over 12 March 1394, preceding the dates covered in the primary horoscope by a mere two weeks, qv in Annex 5. No planets but Mercury and the Moon could alter their positions significantly over this period. However, Mercury was looping a loop, and therefore remained in Pisces throughout the entire period between 5 February and 19 April 1394. The positions of all planets on the spring equinox day of 1394 were thus very close to the primary horoscope. As we already know, in such cases the secondary horoscope of vernal equinox was usually left empty, or almost empty.

However, it is possible that the secondary horoscope of vernal equinox is represented by "planetary doubles" in the Greater Zodiac, as we already mentioned above. Yet the secondary horoscope of vernal equinox cannot be of any use in filtering out the extraneous solutions, since it is de facto a duplicate of the primary horoscope, and all of our preliminary solutions satisfy to its conditions already.

For the sake of making the picture complete, let us cite the planetary positions on the ecliptic for 12 March 1394 (the spring equinox day):

Julian day (JD) = 2230287.00
Year/month/date = 1394/3/12

Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
368.5	121.5	216.1	369.0	344.9	339.6	354.3
11.55	3.12	6.03	11.56	10.90	10.59	11.19
Pisces	Cancer	Libra	Pisces	Aquar.	Aquar.	Pisces

In the sixth column of the verification table we draw another plus sign, since there were no contradictions between the zodiac and the solution in the present case.

The seventh column refers to the secondary horoscope of summer solstice.

Summer solstice fell on 11 June 1394 A.D. for the year under consideration, qv in Annex 5. Let us specify planetary positions on the ecliptic for 11 June 1394 (see above for explanation of indications):

Julian day (JD) = 2230378.00
Year/month/date = 1394/6/11

Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
96.4	236.6	210.9	28.4	53.6	90.9	122.0
2.24	7.00	5.89	0.07	1.05	2.04	3.14
Gemini	Lib/Sco	Virgo	Pisc/Ari	Ari/Tau	Tau/Gem	Cancer

Sun was in Gemini on the day that interests us. The only planets one could find nearby were Venus and Mercury – the "minimal secondary horoscope" planets that never drift too far away from the Sun.

Venus was at the cusp of Taurus and Gemini – invisible, since it crossed the local horizon in Cairo at the solar submersion rate of a mere 5 degrees (as calculated in Turbo-Sky). The solar rays would obscure Venus, its high luminosity of –3.4 notwithstanding. The submersion rate was too low; even moving the hypothetical observation point to Luxor wouldn't help the situation in any way at all.

Mercury was in Cancer, on the side of Gemini. Its matutinal visibility was excellent – it would rise in Cairo at the solar submersion rate of 19 degrees, in complete darkness (see [393], page 16). Thus, Mercury was visible.

There were no other planets in either Gemini or any of the neighbouring constellations; one can therefore expect this secondary horoscope to be minimal in the Greater Zodiac. However, we know that minimal horoscopes of this kind are usually integrated into the figure of Gemini. The male figure stands for Mercury, and the female – for Venus, qv in CHRON3, Chapter 15:8.4. The correspondence between our solution and the Greater Zodiac shall therefore be excellent if there aren't any other planets in the secondary horoscope of summer solstice except for Venus and Mercury.

This is exactly the case. The secondary horoscope of summer solstice in the Greater Zodiac of Esna is minimal. Furthermore, only one of the planets contained therein was visible – Mercury, which was in Cancer; this is exactly where we find the planet in the secondary horoscope of summer solstice. Let us reiterate the corollary we made after analysing this horoscope.

The secondary horoscope of summer solstice from the Greater Zodiac is minimal; it consists of Mercury and Venus. One of the planets – most likely, Mercury, is drawn additionally as a two-headed snake in between Gemini and Cancer.

We shall therefore draw a plus sign in the seventh column of the verification table as well.

There are no additional scenes that could help us in verification of solutions in the Greater Zodiac of Esna. This is where the verification of our solution

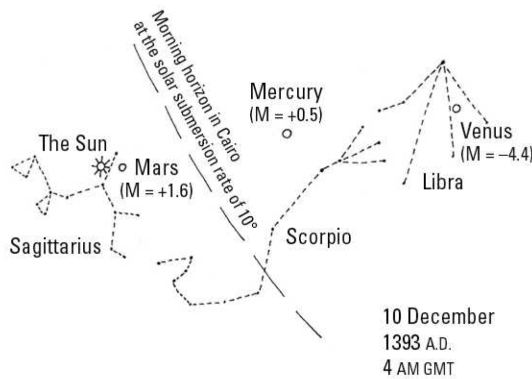


Fig. 17.43. Dislocation of planets in the solar vicinity for 10 December 1393, the day of the winter solstice. One sees the morning horizon in Cairo. The Sun was in Sagittarius. Mercury in Scorpio and Venus in Libra were visible very well before dawn – unlike Mars, which had been too close to the Sun. Calculated in Turbo-Sky. The drawing is approximated.

ends. There are plus signs in all the columns of the verification table, qv in fig. 17.41. The solution is therefore exhaustive.

We found no other exhaustive solution in any interpretation of the primary horoscope in the Greater Zodiac of Esna.

COROLLARY. The Greater Zodiac of Esna contains the following date: 31 March – 3 April 1394 A.D. (a new moon). The best correlation with the zodiac was attained on 3 April 1394, when the new moon was born in Taurus and right over the Pleiades.

6. THE DECIPHERMENT OF THE DATE FROM THE ZODIAC FOUND IN THE LESSER TEMPLE OF ESNA (EM)

In the previous section we provide an account of how we deciphered the date transcribed in the ceiling zodiac of a gigantic ancient Egyptian temple from the town of Esna. We called it the Greater Zodiac of Esna. The date it contained fell over the very end of the XIV century A.D. – namely, 1394. However, it wasn't the only zodiac discovered in Esna. Let us consider the second one now (we call it the Lesser Zodiac), and the date it contains. A comparison of the two datings would be most edifying indeed. In the case of the

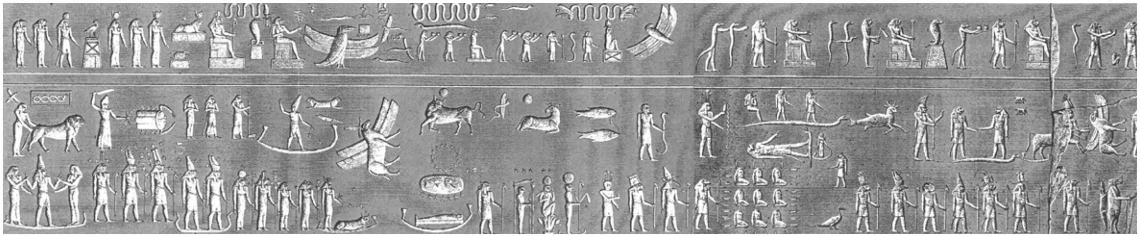


Fig. 17.44. Shaded drawing of the Lesser Zodiac of Esna (EM) taken from the Napoleonic album. Taken from [1100], A. Vol. I, Pl. 87.

Fig. 17.45. Temple found on the north of Esna, a town in Egypt, drawn by the Europeans who came here during Napoleon's Egyptian expedition. The zodiac found in the temple shall be referred to as "the Lesser Zodiac of Esna", or simply "the Lesser Zodiac". Taken from [1100], A. Vol. I, Pl. 85.

Dendera zodiacs we witnessed the two dates to be exceptionally close to each other – the difference between the two equalled a mere 17 years. Could we run into a similar situation in case of the Esna zodiacs? The answer is in the positive – this is exactly what happens here. The difference between the dates from the two temples equals 10 years.

As we mentioned above, the Egyptian town of Esna is located on the banks of the Nile, where we find the southern end of the "Bight of the Kings" on the Nile. This town is presumed to have possessed the Greek name of Latopolis once ([1100]). Apart from the large temple where the Greater Zodiac was discovered, there is another temple in Esna that contained a zodiac of the same type. This temple is a lot smaller, and we shall therefore refer to it as to the Lesser Temple of Esna, with the corresponding zodiac known as the Lesser Zodiac. A drawn copy of this zodiac from the Napoleonic Egyptian album can be seen above in fig. 12.20, and a shaded copy from the same source is cited in fig. 17.44.

The Lesser Temple is located in the north of Esna. Europeans that came here during the Egyptian expedition of Napoleon found the temple in a decrepit state – at least, this is how we find it drawn in the Napoleonic album ([1100]; see fig. 17.45).

This is probably the reason why a part of the Lesser Zodiac is lost – namely, the entire area of Scorpio, Libra and Virgo. However, fortunately enough, the lost fragment doesn't preclude us from deciphering the date contained in the zodiac, since all of the primary horoscope's planets are in the remaining part.

Let us proceed with our analysis of the Lesser Zodiac from Esna and the interpretation of the date ciphered therein by the "ancient" Egyptians.

6.1. Drawn copies of the zodiac from the Lesser Temple of Esna

The purposes of dating require more detailed copies of the zodiac than the one found above in fig. 12.20. They can be found in figs. 17.46, 17.47 and 17.48. These drawings make it easy to follow all the details of the Lesser Zodiac's analysis.

We already mentioned the fact that there were no other drawings of the Esna zodiacs at our disposal except the one found in the Napoleonic album ([1100]). We had no photographs of the Lesser Zodiac; however, the drawings from the Napoleonic album are detailed enough to suffice for the interpretation and dating of the Lesser Zodiac from Esna.

As usual, we shall give a step-by-step account of our dating procedure, qv in CHRON3, Chapter 16:7.

6.2. The coloured version of the zodiac

Step 1, qv in CHRON3, Chapter 16:7.1. The initial interpretation of the primary horoscope and the

compilation of the "coloured version" of the Lesser Zodiac. The coloured version can be seen in figs. C7, C8 and C9.

The comprehensive tables of Egyptian symbols as seen in CHRON3, Chapter 15:1, make it easy to find all figures of zodiacal constellations that we can find in the Lesser Zodiac of Esna except for the ones that wound up in the destroyed part. All the surviving figures of constellations and planets are drawn in the exact same manner as in the Greater Zodiac of Esna as covered above. In general, they're the same constellation figures we find in the Zodiacs of Dendera.

In the Lesser Zodiac of Esna we see the constellation figures of Leo (with an "auxiliary Virgo"), Gemini, Taurus, Aries, Pisces, Aquarius, Capricorn and Sagittarius. The figure of Sagittarius is next to the destroyed part, it is also damaged rather badly. The missing part should have contained the figures of the missing constellations – Scorpio, Libra and Virgo.

All the constellation figures are in the central row of the Lesser Zodiac.

Before we go any further, let us pay attention to the fact that all of the figures contained in the Lesser Zodiac of Esna are arranged in three rows or strips, qv in figs. C7, C8 and C9.

The lowest row contains the planets of the primary horoscope. They are highlighted yellow in the coloured version of the zodiac. Here we find all the wayfarer figures with the canonical planetary rods, as seen above in fig. 15.29. The same row contains the scene that involves the Passover full moon, qv in CHRON3, Chapter 15:9.1. Apart from that, we find some secondary horoscope symbols here, among them the familiar calf in a boat with the woman firing an arrow over his head. We see no bow in her hands this time, but the actual projectile is in plain sight right over the head of the calf. All the secondary horoscope symbols are highlighted in blue.

There are some other symbols in the lowest row, highlighted in red. These symbols are novel to us, and we haven't encountered them in any other zodiacs as to yet. We call them "constellation parentheses"; see more below.

In the central row we find the zodiac's constellation figures highlighted red in the coloured version of the zodiac; apart from those, we see several secondary horoscope symbols here, highlighted in blue. There is also an additional astronomical scene between Aquarius and Capricorn, highlighted in green.

The two rows occupy most of the Lesser Zodiac's space. What we see in action here is separation into constellations as defined by the figures of the latter found in the central row. The top row is explicitly separated from the space of the first two rows; we

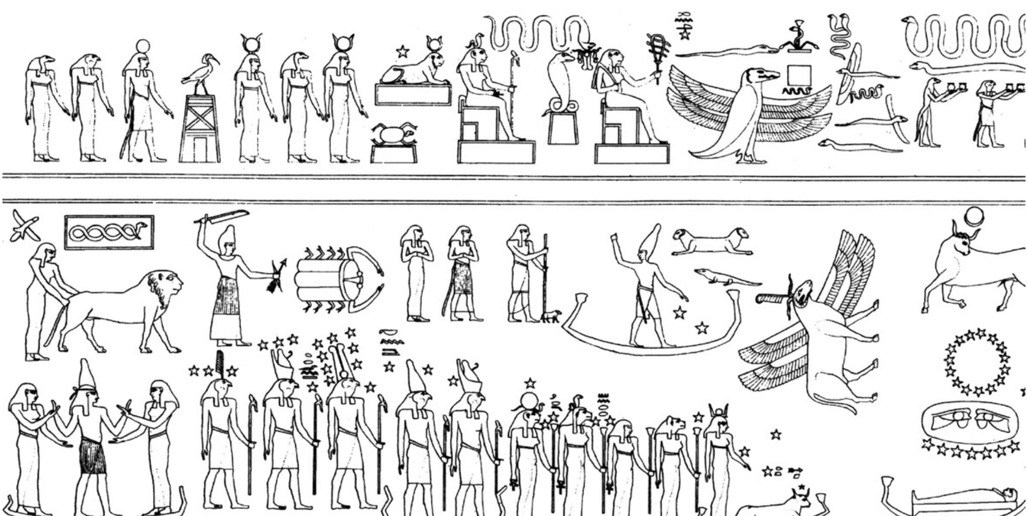


Fig. 17.46. The Lesser Zodiac of Esna (EM). First part of the drawn copy from [1100], A. Vol. I, Pl. 87.

Fig. 17.47. The Lesser Zodiac of Esna (EM). Second part of the drawn copy from [1100], A. Vol. I, Pl. 87.

shall witness it to contain a distinction mark of its own. Therefore, its correspondence to the constellation figures of the central row is very approximate.

The entire top row is dedicated to the symbols of secondary horoscopes. They are highlighted blue in the coloured version of the zodiac. Since all of the figures in this row pertain to secondary horoscopes, the transposition symbols as mentioned in CHRON3, Chapter 15:6 aren't used here due since they aren't really needed for any purpose whatsoever. We see four equinox and solstice symbols in this row, if we are to proceed from the tail of the general procession towards its head (left to right, that is). Let us list them here.

The autumn equinox symbol is a bird that resembles a heron that stands upon a crossed-out dais, which symbolizes equinoxes in Egyptian zodiacs, qv in CHRON3, Chapter 15:8. The symbol's approximate location is over the figure of Leo and the "auxiliary Virgo" (see CHRON3, Chapter 15:1.5) in the central row. It is shifted towards Cancer somewhat. Right here in the central row we find another Egyptian equinox symbol that we already mentioned in CHRON3, Chapter 15:8. It has the appearance of a snake whose body is woven into a complex symbol, as seen highlighted blue in the coloured version of the zodiac, right over the back of Leo with the "auxiliary Virgo".

We must point out that the primary symbolism of the autumn equinox point was located in the destroyed part of the top row, above the constellation of Virgo, whereas Leo and the "auxiliary Virgo" only ended up with the "tail-lights" of this secondary horoscope, as was the case with the Greater Zodiac of Esna.

Further we encounter a summer solstice symbol as we move along the top row from the left to the right – it is a cobra sitting on a dais, qv in CHRON3, Chapter 15:8. Right underneath we see the symbol of Gemini that looks like three figures following one another – it is just the same here as in the Greater Zodiac of Esna. Gemini is where we find the summer solstice point in Egyptian zodiacs, qv in CHRON3, Chapter 15:8.4.

Further to the right we see the spring equinox symbol – a naked human figure sitting with crossed legs over a crossed-out dais. We find the constellation of Pisces underneath, which is where we find the vernal equinox point.

Finally, we see a winter solstice symbol – a cobra on a dais, just the same as we saw in case of the summer solstice. It is located above Sagittarius in the central row, but slightly shifted towards Capricorn. Everything makes perfect sense – the winter solstice point is in Sagittarius.

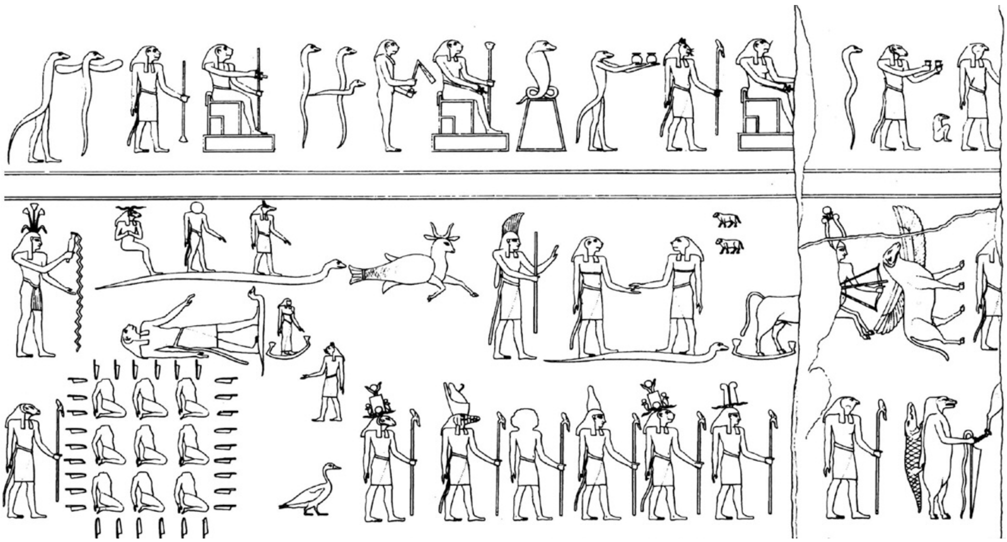


Fig. 17.48. The Lesser Zodiac of Esna (EM). Third part of the drawn copy from [1100], A. Vol. I, Pl. 87.

Next we find the destroyed part of the top row. This is where we would probably find the main symbol of the autumn equinox, heading the entire procession of figures in the Lesser Zodiac. All of it corresponds to the September year that began around the time of the autumn equinox.

Round about each of the equinox and solstice symbols in the top row we find the planetary symbols from the corresponding secondary horoscopes. The winter solstice horoscope is the most "saturated" and occupies almost half of the top row. See more on secondary horoscope symbols in the Lesser Zodiac below.

6.3. "Constellation parentheses" in the primary horoscope's planetary row in the EM zodiac

Let us study the lower row of the Lesser Zodiac with more attention. It is very important to us, since this is where we find the date of the Lesser Zodiac transcribed as the primary horoscope. At the same time, the symbolism of this row proved complex enough. Unlike the top and middle rows, whose symbolism is more or less standard, we encounter a new and unfamiliar series of symbols that proved to be quite troublesome in our analysis of the Lesser Zodiac.

Let us put the events into a sequence. As we approached the decipherment of the Lesser Zodiac, we instantly noticed the fact that the lower row contained an exact total of five wayfarer groups with planetary rods; there is a different number of wayfarers in each of the groups, but they all follow each other inside every group. The groups themselves are separated from each other by other symbols – either in boats or without planetary rods.

As we have already seen in the Greater Zodiac of Esna, each of these groups must represent some planet from the primary horoscope. Let us now recollect that the number of planets represented by planetary circles equals five (the Sun and the Moon excepted, since they were represented by circles and not wayfarers). The number corresponds to that of the wayfarer groups in the Lesser Zodiac. One of the groups is female, and located under Gemini from the central row, somewhat to the side of Taurus. This is perfectly in order, seeing as how only one of the planets known in ancient astronomy was "female" – Venus. It might seem odd that it should be represented by four figures here, and not two as usual. Two of them are obviously larger than the other pair; we aren't certain about the exact meaning of these symbols so far. It is nonetheless obvious that the planet drawn here is

Venus. The identity of other planets is less apparent, although many of them can still be recognized from all of what we know about planetary symbolism of the primary horoscope in Egyptian zodiacs, qv in CHRON3, Chapter 15:4.

However, when we made the attempt of dating the zodiac, arranging the planets on the ecliptic in accordance with the constellation (or constellation group) of the central row located above it, we came up with no exhaustive solutions at all. We have tried every possible identification option for the wayfarer groups from the lower row, having also tried every possible version in case of the Sun and the Moon – to no avail, since no exhaustive solution satisfying to the symbolism of the primary horoscopes could be found this time.

We have meditated thereupon for a while, and our attention was caught by two apparent symbols of the Aquarius constellation among the "extra-planetary" figures of the lower row, the first one being the male figure underneath the constellation of Pisces that wears a typically Aquarian headdress, qv in CHRON3, Chapter 15:1.11. An identical headdress can be spotted on the actual figure of Aquarius in the central row. The second symbol of Aquarius in the lower row is nine decapitated male figures surrounded by a hem of daggers. We find the symbol underneath Aquarius, shifted towards Capricorn a little bit. This is also a symbol of Aquarius familiar to us from other Egyptian zodiacs, qv in CHRON3, Chapter 15:1.11.

The most interesting thing is that the Aquarian symbols are separated from one another, with one of the planetary groups located right in between them. The group is therefore confined within "Aquarian parentheses" of sorts. One can therefore come up with the obvious assumption that the artist wanted to emphasise that the planet in question is located in Aquarius. Otherwise it would be easy to ascribe the planetary group to Pisces instead, since it is located at an equal distance from both Aquarius and Pisces in the central row.

In the present case the "Aquarian parentheses" add nothing of substance to our interpretation of the Lesser Zodiac. We must calculate both versions for the planet in question at any rate.

However, having made this simple observation, we couldn't help assuming that there may be other "constellation parentheses" of this kind in the zodiac – possibly indicating more radical shifts of the lower row in relation to the top. This might be the reason why no exhaustive solution can be arrived at – erroneous distribution of planets across constellations. If the bottom row is strongly "warped" in relation to the centre, we can make a grave mistake in this place as we define planetary positions according to their disposition in relation to the constellations above, and come up with no correct interpretations of the primary horoscope. Zodiacal solutions for false interpretations will obviously fail to concur with secondary horoscope symbolism. There can therefore be no exhaustive solution in this case.

This is how it turned out. The bottom row of the Lesser Zodiac contains another pair of "constellation parentheses" related to Gemini. The "devious" plan of the Egyptian artist involved using a different Gemini symbol for these parentheses – the standard one instead of the odd three-figure symbol as seen in the Lesser Zodiac, which makes it differ from the majority of Egyptian zodiacs in that respect; they all use two figures integrated into a complex astronomical hieroglyph of the constellation figure with a minimal horoscope of summer solstice, qv in CHRON3, Chapter 15:8.4. One of the Gemini figures (the male one) simultaneously stands for Mercury in the minimal secondary horoscope, whereas the female figure represents Venus. The former has a feather on its head (a symbol of Mercury), whereas the latter is crowned by a circle with a snake, qv in fig. 4.67 above.

We see such a pair of figures in the bottom row of the Lesser Zodiac of Esna under the constellations of Leo, Cancer and Gemini in the central row. They are the "Gemini parentheses" of the Lesser Zodiac marked red in the colour version. These "parentheses" include a single planetary group of two figures and another similar figure in a boat (bearing no relation to the primary horoscope, that is, qv in CHRON3, Chapter 15:6.

This planet must therefore have been in Gemini, unlike the rest; this affects the interpretation of the primary horoscope greatly, since the planet found inside the "Gemini parentheses" is located right over Cancer in the central row. Without the parentheses it would be a very far-fetched suggestion to ascribe it to Gemini. Furthermore, Venus (the female group) is located right underneath Gemini and at a consider-

able distance from Taurus in the central row; it would be impossible to ascribe it to that constellation otherwise. However, it becomes clear that Venus was either in Taurus or on the cusp of Gemini and Taurus, since it is drawn outside the "Gemini parentheses", although right next to them. The constellation that neighbours with Gemini from the other side is Taurus.

It becomes perfectly clear why there are two larger and two smaller figures in the group of Venus that we initially ascribed all four female figures with planetary rods to, whereas in all other zodiacs it is represented by two wayfarers of an identical height. This appears to be the case with the Lesser Zodiac as well; larger figures relate to the "Gemini parentheses" and not Venus itself. They resemble Venus for the sole reason that they correspond to the Gemini figure of Venus in the "astronomical hieroglyph" of summer solstice, qv in CHRON3, Chapter 15:8.4. The hieroglyph is divided in two, each of its halves serving as one of the "Gemini parentheses" from the bottom row.

In the coloured version of the zodiac, the two female figures that relate to "Gemini parentheses" are highlighted in red, whereas the ones that stand for Venus in the primary horoscope are yellow.

6.4 Planetary figures of the primary horoscope in the EM zodiac

Let us begin with the Sun and the Moon. We only see two circles in the Lesser Zodiac that could serve as representations of the two luminaries; both are in the central row. One of the circles can be found over the horns of the Taurus figure, and the other over Aries. This was the case in the Greater Zodiac of Esna as well, the difference being that the size of both circles coincides in this case. We shall therefore consider two possibilities at once, as we did in case of the Greater Zodiac.

1) Sun in Taurus, Moon in Aries, or

2) Sun in Aries, Moon in Taurus.

The exhaustive solution demonstrates the former to be true.

The symbols of the remaining five planets are in the bottom row, as we already found out in our compilation of the coloured zodiac. They are drawn as groups of wayfarers carrying planetary rods. Once again, we're fortunate – none of them ended up in the missing part.

The only planet from the bottom row that we can recognize instantly is Venus. We had to sort through all possibilities for other planets in order to minimise the impact of guesswork in final identification. Nevertheless, in the final exhaustive solution all of the preliminary considerations we made herein turned out to have been perfectly valid (see more details in CHRON3, Chapter 15:4, where we discuss planetary symbolism of the primary horoscope's planets in various Egyptian zodiacs – in particular, the Lesser Zodiac of Esna).

Let us list the planetary groups found in the bottom row of the Lesser Zodiac, pointing out the identification made in accordance with the exhaustive solution. We shall proceed from left to right, moving from the surviving end of the zodiac towards its destroyed part. All the planetary groups are highlighted yellow in the coloured version.

The first planet is drawn as two wayfarers with heads of falcons, bearing planetary rods. They are wearing tall hats. According to the final solution, these figures represent Mars in the primary zodiac. The man with a planetary rod, a falcon's head and a head on his shoulder is the "left parenthesis of Gemini" – the planet was therefore located in Gemini. The wayfarer in front has a star over his face – a visibility indicator. It is however obvious that the planet in question had been visible – it is too far away from the Sun in the zodiac.

On its right we see the same planet, but already in a boat. This means its place is in a secondary horoscope and not the primary. We shall deal with it later. Further right one finds the "right Gemini parenthesis". Next in our motion to the right along the lower row of the Lesser Zodiac we encounter the second planet, drawn as two women with leonine heads and planetary rods. The one in front has a leonine head. It is Venus, qv in CHRON3, Chapter 15:4.8 in re the symbolism of Venus in the primary horoscope. We see it immediately after this "parenthesis", or in Taurus. Therefore, Venus was in Taurus or at the cusp of Taurus and Gemini. There is a star over the face of the woman in front – a visibility indicator. It is of importance to us here, since the Sun can be located in Taurus. And so, Venus was visible.

The third planet is a lone male figure with a human face carrying a planetary rod. The exhaustive solution identifies it as Mercury located underneath Taurus and Aries, which means the planet was in one of the constellations in question. The figure of Mercury has no star anywhere near its face, which means the planet was invisible.

The fourth planet is represented by three male wayfarers; one of them has got the head of a ram, and the other has got the head of an ibis. According to the exhaustive solution, the planet in question is Saturn; see also CHRON3, Chapter 15:4.2 and 15:4.3, where we discuss the symbolism of Saturn in the primary horoscopes of Egyptian zodiacs. This planet is enclosed into the "Aquarian parentheses", and must have therefore been located in Aquarius. There is a star in front of the wayfarer in the middle – a visibility indicator. However, at this distance from the Sun visibility indicators become useless, since the planets located here cannot be invisible by definition; the indicators were therefore optional.

Fifth planet – long procession of seven male wayfarers near the right edge of the Lesser Zodiac's surviving part. Among them we find figures with heads of humans, falcons, rams, crocodiles and lions. The procession is followed by a goose. We therefore see attributes of Jupiter in the "entourage" of the planet (leonine head and a characteristic headdress), Mars (falcon's head and the goose) and Mercury (human face or crocodile's head). The exhaustive solution identifies the planet as Jupiter; see CHRON3, Chapter 15:4.6 for a discussion of the identification.

We don't find a single figure with a star in front of its face here; however, it is possible that there was one – right where we find the destroyed fragment, in front of the second figure's face. However, at this distance from the Sun (when the visibility of the planet is obvious), indicators would often become omitted. We ran into such situations above.

The entire procession is located under Capricorn and Sagittarius in the central row; the planet must have been in one of the constellations.

Thus, the decipherment of the primary horoscope of the Lesser Zodiac from Esna, for which we came up with a complete solution, is as follows:

Sun in Taurus.

Moon in Aries.

Mars in Gemini (enclosed into "Gemini parentheses"). Visible.

Venus in Taurus (possibly at the very edge of Gemini, at the side of Taurus). Visible.

Saturn in Aquarius (enclosed into "Aquarius parentheses").

Jupiter in either Capricorn or Sagittarius.

The above decipherment of the Lesser Zodiac's primary horoscope corresponds to the exhaustive solution that dates it to 6-8 May 1404, qv below.

6.5. Secondary horoscopes and auxiliary scenes in the EM zodiac

6.5.1. Autumn equinox horoscope in the EM zodiac

As we already know, the area of this secondary horoscope in Egyptian zodiacs covers the constellation of Virgo as well as its neighbours – Leo and Libra, qv in CHRON3, Chapter 15:8. The fragment of the Lesser Zodiac with the constellations of Virgo and Libra is destroyed. Nevertheless, the part with Leo and the "auxiliary" Virgo standing over the figure's tail (see CHRON3, Chapter 15:1.5 and CHRON3, Chapter 15:1.6 for more details on the symbolism of Leo and Virgo in Egyptian zodiacs). Therefore, a part of the horoscope of autumn equinox managed to survive on the Lesser Zodiac, qv in fig. 17.46, as well as the coloured version of the zodiac in fig. C7.

In the top row near the autumn equinox sign (the crossed-out dais with a heron on top) we see six figures, one of them male, with a circle over its head. All the other figures are female and represent Venus, whereas the male one is most likely to stand for Mercury, since it has a human face, and that's a distinctive characteristic of Mercury in Egyptian zodiacs, qv in CHRON3, Chapter 15:4.9-10. To the right of these figures we see a lion and a bug on daises, with a star shining right over the former. This must be a reference to good visibility of some planet in Leo on the day of spring equinox. Therefore, all we see here is a minimal horoscope of Venus and Mercury, and learn of some bright planet in Leo.

In the middle row we see an autumn equinox symbol over the figure of Leo with an "auxiliary Virgo" – it looks like a tablet with a snake bent in two close nearby. To the right, between Leo and Cancer, we see a militant male figure (stepping wide) with a sword

in one hand and a quiver of arrow in the other. It must be Mars. However, it can relate to this horoscope as well as the neighbouring horoscope of summer solstice, since we find it at an equal distance from Virgo and Gemini. There are no secondary horoscope symbols anywhere near in the central row.

In the bottom row, right near the edge and underneath Leo with the "auxiliary Virgo" we see a boat with a man standing inside it, supported by two similar female figures from either side. This must stand for Venus meeting some other planet – a "male" one, or, alternatively, the Sun. This scene shall therefore be useless in the verification of solutions, since purely astronomical considerations make it obvious that Venus passed by around this time, and that it was close to the Sun. Furthermore, such "meetings" can figure as auxiliary scenes in Egyptian horoscopes, bearing no relation to secondary horoscopes – like Mars meeting Saturn in the Long Zodiac of Dendera, qv above. Therefore in the painted zodiac the "meeting" scene is highlighted blue and green.

The corollary is as follows:

The only planets we find in the surviving part of the autumn equinox horoscope in the Lesser Zodiac are Mercury and Venus. Mars between Cancer and Leo can also relate to this secondary horoscope – or, alternatively, the secondary horoscope of summer solstice. Some bright planet was present in Leo on the day of autumn equinox. The part of the autumn equinox horoscope located in the vicinity of Virgo and Libra didn't survive; it may have contained some planets.

6.5.2. Winter solstice horoscope in the EM zodiac

The area of this secondary horoscope covers Sagittarius and the neighbouring constellations of Capricorn and Scorpio. The constellation of Scorpio in the Lesser Zodiac is destroyed; however, Sagittarius and Capricorn are in excellent condition. Apart from that, the secondary horoscope of spring equinox occupies a great deal of space in the top row of the Lesser Zodiac. The remaining secondary horoscopes found in the same row are a lot shorter, and the figures they contain, smaller, qv in figs. 17.47 and 17.48 as well as the coloured zodiac in figs. C8 and C9. See also fig. 12.19 where we see the Lesser Zodiac in its entirety.

In the top row, around the abovementioned symbol of winter solstice (cobra on a dais) we see three walking figures with planetary rods. We don't see the rod of the figure on the far right, since it ended up in the destroyed part; however, we see the figure's arm reaching forward in the exact same manner as the arms of other figures that carry staves, or rods. We know nothing of what may have been depicted to the right of the figure; possibly, other figures carrying staves.

Walking figures with rods are accompanied by sitting figures with similar rods as well as fantasy animals – "snakes with legs" as well as vertically-aligned snakes. In general, the symbolism of the procession bears great resemblance to the primary horoscope in the Greater Zodiac of Esna, which we already managed to understand, qv above. However, in this case the horoscope is secondary and not primary. Bear in mind that all of the figures in question are located in the special top row of the Lesser Zodiac specifically allocated for secondary horoscopes and separated from the rest of the zodiac.

Thus, if we are to use the already deciphered Greater Zodiac of Esna, we can try to understand what is drawn here. This is easy enough.

Let us begin with the tiny animal hiding neat the feet of the wayfarer in the far right. In the Greater Zodiac of Esna two similar animals were used as a symbol of Mercury, qv in its coloured version, where we find this figure a little to the right from Aquarius. It was highlighted green, which means that it's part of a planetary figure's entourage in the primary horoscope (Mercury in the present case, qv above). We see no second animal here – this part of the zodiac got destroyed. However, its former presence in this precise spot becomes obvious from a comparison with the Greater Zodiac.

The planet referred to here is therefore Mercury.

Furthermore, all the sitting figures holding staves are female, which is emphasised graphically (the figure on the far left might be an exception, since its arm obscures its breast). Apart from that, we see several vertically aligned snakes on the left of the solstice sign. We already know them to symbolise Venus or Mercury, qv in CHRON3, Chapter 15:4.10. However, Mercury is in the far right, and there's a separate vertical snake close to its figure – therefore, what we're seeing here must be Venus (it is most likely to be represented by all three sitting figures simultaneously), as well as the wayfarer with a rod and a leonine head

on the far left, just like the male figure that accompanies Venus in the Greater Zodiac of Esna, as well as the Long Zodiac of Dendera. The second wayfarer with a staff that looks very much alike must stand for Jupiter, according to the Greater Zodiac. Indeed, in the Greater Zodiac Jupiter was accompanied by a similar wayfarer with a leonine head – just like the one that accompanies Venus.

Let us now consider the central row and the bottom row in this part of the Lesser Zodiac.

In the central row we see a spring equinox symbol over a snake (or transposed) in between Capricorn and Sagittarius, qv in CHRON3, Chapter 15:6. This makes perfect sense – spring equinox point is elsewhere, a lot further to the left (in Pisces). Therefore, its symbol is out of place – transposed, which is indicated accordingly. The meaning is easy to understand – the spring equinox symbol transposed towards Sagittarius is most likely to mean that the area of the spring equinox horoscope begins right here, to the left of Sagittarius. Otherwise, this zodiacal area would be occupied by the secondary horoscope of winter solstice. Thus, the secondary horoscope of spring equinox would cross the boundary of it's neighbour's area, having chased it away from this place in the central row. To the right of Sagittarius the destroyed part of the zodiac begins.

Now let us study the bottom row. It contains no secondary horoscope symbols whatsoever, which is reflected in the absence of blue highlighting from the corresponding parts of the horoscope's coloured version.

Let us sum up.

In the secondary horoscope of winter solstice Mercury must have been in Sagittarius or close nearby, as well as Venus and another planet – most likely, Jupiter. Apart from that, some planets may have been in Scorpio or Sagittarius, on the side of Scorpio. However, this part of the zodiac has been destroyed.

6.5.3. The horoscope of vernal equinox and the additional scene between Aquarius and Capricorn in the EM zodiac

On the day of vernal equinox the Sun in every Egyptian Zodiac was shown in Pisces, qv in CHRON3, Chapter 15:8.3. Therefore, the secondary horoscope area includes Pisces and the neighbouring constellations of Aries and Aquarius. However, as we already mentioned, we find said area occupied by this horoscope in the central row is stretched up until the figure of Sagittarius, qv in figs. 17.47 and 17.48, as well as the coloured version of the zodiac in figs. C8 and C9.

We shall once again begin with the top row. All we see in the immediate vicinity of the spring equinox symbol (a crossed-out dais with a naked figure on top) is the minimal secondary horoscope symbolism, or the figures and signs of Mars and Venus, qv in fig. 17.47 as well as the coloured zodiac in fig. C8. We shall therefore find nothing useful for decision verification. The presence of Mercury and Venus near the Sun tells us nothing, since these planets are never too far away from the Sun in their celestial motion.

We see a great many figures in the area of this secondary horoscope in the central row. There is a two-faced man with a vertical snake in his hand in between Pisces and Aquarius; he possesses all the attributes of Mercury, qv in CHRON3, Chapter 15:4.9-10. Therefore, Mercury was in Pisces or Aquarius on the day of the spring equinox.

In between Aquarius and Capricorn we see a whole collection of planetary figures on snakes or in boats – six of them altogether. They're highlighted green in the coloured zodiac, being most likely to represent an auxiliary astronomical scene. There are too many planets here for a single secondary horoscope; finally, the most important consideration is that the secondary horoscope planets are drawn without transposition symbols in the central row, since the primary horoscope's planets are absent from it, and there is no danger of confusing them. However, all the figures on the scene have got transposition symbols (snakes or boats), except for one tiny figure at the very bottom.

In the upper part of this auxiliary scene we see three figures over a single snake. The figure in front has the head of a jackal. It is in motion, likewise the one that follows it, with a circle instead of its head. Finally, the third figure is sitting. The scene is most likely to represent half of Mercury's loop around the Sun. Mercury had been visible initially; this was followed by its disappearance behind the Sun (circle instead of head); then it headed forwards and stopped (sat down) before turning back towards the Sun. This is how Mercury moves across the celestial sphere.

In front of this snake we see a large figure of a man riding a snake in a direction perpendicular to the

zodiacal strip. On its right we see a tiny figure of a female in a boat – possibly Venus. Further to the right and downward we see a male figure with the head of a lion (or a cat), facing the opposite direction, or the left of the zodiacal field. Therefore, we see three more planets taking part in the additional scene, one of them being Venus.

We therefore see four planets in the additional scene, Venus and Mercury included in their number. Since the entire scene is located at the cusp of Aquarius and Capricorn, there were four planets in conjunction with the Sun in Aquarius or Capricorn (in January or February). This entire scene from the Lesser Zodiac is very close to the figure of Aquarius, as well as the "Aquarian parentheses" in the bottom row depicting decapitation scenes. As we mentioned in Chron3, Chapter 15:1.11, Aquarius was likely to symbolise John the Baptist in Egyptian zodiacs. In particular, one of the key Christian feasts falls on 6 January, and it is related to John the Baptist immediately – The Feast of the Epiphany. It would therefore be especially interesting to take this feast into account in our verification of solutions, and see whether it is indeed true that a total of 4 planets gathered near the Sun on this day. Below we shall allocate a separate verification table column to this.

Let us however return to the secondary horoscope of vernal equinox. There is one figure left in the central row that we haven't mentioned as to yet – the man with a rod in his hand and a tall headdress. To his right we see the transposed vernal equinox symbol, which marks the border of the secondary horoscope under study. Thus, we see yet another planet in Capricorn – or, possibly, in between Capricorn and Sagittarius. There are no secondary horoscope symbols in the lower row in this part of the zodiac. As for the secondary horoscope of spring equinox, apart from the minimal horoscope of Mercury and Venus we see another planet in Capricorn or at the cusp of Capricorn and Sagittarius. Apart from that, we learn more about the position of Mercury, which was in either Pisces or Aquarius.

6.5.4. Summer solstice horoscope in the EM zodiac

The Sun is shown in Gemini on the day of summer solstice, qv in Chron3, Chapter 15:8.4, where we find a discussion of the summer solstice point's symbolism in the Lesser Zodiac from Esna.

Let us take a closer look at this secondary horoscope of the Lesser Zodiac.

In the top row, on both sides of the summer solstice symbol (cobra on a dais) we see two sitting female figures. One of them is to the left of the solstice sign and holds a canonical planetary rod, whereas the other one is holding some sort of loop, crossed by three zigzags. The fact that both figures are female is emphasised graphically; therefore, the planet we have in front of us is doubtlessly Venus.

The next thing we see on the right is an agglomeration of symbols that resemble the ones found near the summer solstice point on the Greater zodiac, where we find something very similar to the left of the Gemini figure. If we are to mention planets, one can also point out the presence of a bicephalous snake here – apparently, a symbol of Mercury.

Therefore, the only thing we see in the top row is a minimal horoscope. No other planets are represented here except for Venus and Mercury.

In the central row we see the Egyptian solstice symbol found here the most often – a man in a boat with his arm raised into the air, qv in Chron3, Chapter 15:8.4. Nearby we find a two-headed animal and a crocodile symbolising Mercury and Venus in the minimal horoscope of the summer solstice point. However, to the left of Cancer we see the abovementioned figure of a warrior with a sword and a bunch of arrows in his hands. This must be Mars – either in this horoscope, or that of the autumn equinox.

In the bottom row, underneath Gemini, we find another familiar symbol of summer solstice – a calf in a boat and a woman firing an arrow over the calf's head. The woman isn't holding a bow, but we see the arrow over the head of the calf nevertheless, qv in Chron3, Chapter 15:8.4. Apart from that, in the "Gemini parenthesis" we see the same planet, already in a secondary horoscope, next to the first planet of the primary horoscope represented by two wayfarers with falcon heads. The boat is a transposition symbol, qv in Chron3, Chapter 15:6. The final solution identifies the planet as Mars, as we already mentioned above. Therefore, our verification of the complete solution must make it certain that Mars was in Gemini or somewhere right next to this constellation. This is in good concurrence with the symbol that resembles a warlike man holding a sword and looking ready to

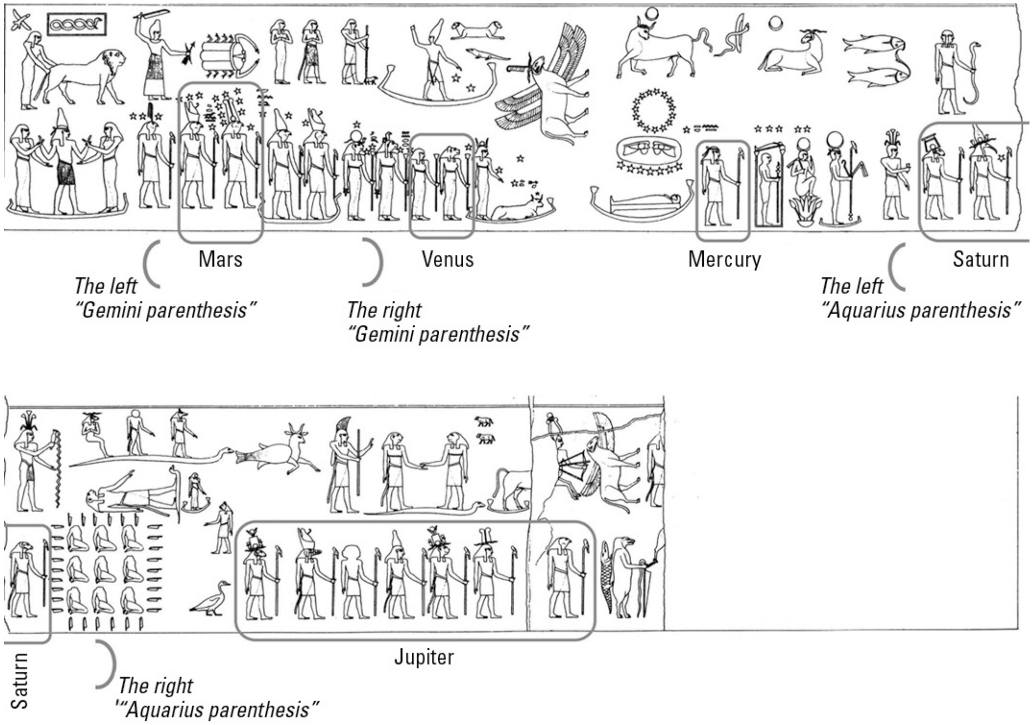


Fig. 17.49. The final interpretation of the primary horoscope transcribed in the Lesser Zodiac from Esna (EM), which yielded an exhaustive solution. Groups of figures related to each planet of the primary horoscope (except for the circles above Taurus and Aries representing the Sun and the Moon) are highlighted and signed. Based on the drawn copy from [1100], A. Vol. I, Pl. 87.

strike that we see between Leo and Cancer in the central row. If this symbol relates to the horoscope as well, Mars must be in between Gemini and Cancer, since it's in Gemini in the bottom row, and right next to Cancer in the central.

We therefore come up with the following horoscope.

Apart from the minimal horoscope comprised from Venus and Mercury, we also see Mars near Gemini – either in the constellation, or (if the warlike figure next to Cancer also pertains to this horoscope) on the cusp of Gemini and Cancer.

6.6. The exhaustive solution of the EM zodiac: 6-8 May 1404 A.D.

The exhaustive solution of the Lesser Zodiac from Esna also proved to be unique. It falls on the interval between 6 and 8 May 1404 A.D., postdating the date transcribed in the Greater Zodiac by a mere 10 years. Planetary positions on the celestial sphere were as follows:

Sun in Taurus,
Moon in Aries (a dying crescent),
Mars in Gemini,
Venus in Gemini, close to the Taurus cusp,
Mercury in Taurus, close to the Aries cusp,
Saturn in Aquarius,
Jupiter in Capricorn.

The concurrence with the primary horoscope is absolute, qv in CHRON3, Chapter 17:6.4 above.

The source data for the Horos program as used for the search of a solution can be seen in Annex 4.

In fig. 17.49 we cite the exhaustive interpretation of the Lesser Zodiac that yielded a complete solution.

Let us cite exact positions of the planets on the ecliptic on the days covered in our solution. The indications are just as they have been all along – the first

row of numbers under the names of planets refers to the longitudes of planets on the J2000 ecliptic in degrees, and in the next row we find planetary positions on the "constellation scale", qv in CHRON3, Chapter 16:10.

THE EXHAUSTIVE SOLUTION OF THE LESSER ZODIAC FROM ESNA (EM) – PRIMARY HOROSCOPE

Julian day (JD) = 2233995.00 <The Moon is 26 days old>
Year/month/date = 1404/5/6

Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
62.4	24.4	331.7	324.4	97.6	85.2	57.8
						(longitude)
1.29	11.95	10.13	9.81	2.28	1.88	1.16
Taurus	Pisc/Ari	Aquar.	Capr.	Gemini	Taurus	Taurus

Average deviation from "best points": 10.2 degrees.

Julian day (JD) = 2233996.00 <The Moon is 27 days old>
Year/month/date = 1404/5/7

Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
63.4	38.5	331.7	324.4	98.2	86.4	57.3
						(longitude)
1.31	0.48	10.13	9.82	2.30	1.92	1.15
Taurus	Pisc/Ari	Aquar.	Capr.	Gemini	Taurus	Taurus

Average deviation from "best points": 8.1 degrees (local minimum).

Julian day (JD) = 2233997.00 <The Moon is 28 days old>
Year/month/date = 1404/5/8

Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
64.3	52.4	331.8	324.5	98.9	87.6	56.8
						(longitude)
1.34	1.02	10.13	9.82	2.32	1.95	1.14
Taurus	Pisc/Ari	Aquar.	Capr.	Gemini	Taurus	Taurus

Average deviation from "best points": 9.9 degrees.

The best correspondence with the Lesser Zodiac was achieved on 7 May 1404, when the dying moon could be seen in Aries as a narrow crescent. Average deviation from "best points" only equalled 8 degrees on that day – a quarter of a constellation's average length on the ecliptic. As we already mentioned, even a deviation twice this size (circa 15 degrees) already implies good correspondence between calculated planetary positions and the indications of a zodiac. The concurrence here is nothing short of ideal.

6.7. The verification table for the exhaustive solution of the EM zodiac

We shall relate the verification results for the exhaustive solution of the Lesser Zodiac that we came up with (6-8 May 1404), satisfying to the conditions specified by secondary horoscopes and planetary visibility indicators. A verification table for this solution is presented in fig. 17.50.

Bear in mind that by an exhaustive solution we understand one that has got a plus sign in every column of the verification table. In other words, an exhaustive solution is one that corresponds to the source zodiac to the minor detail, qv in CHRON3, Chapter 16:14.

As for planetary visibility symbols, they have to be checked for Mercury, Venus and Mars – the only planets that can be rendered invisible by proximity to the Sun. Other planets in the Lesser Zodiac are at too great a distance from the Sun and were visible a priori. Visibility indicators of the planets located far away from the Sun would often be omitted from Egyptian zodiacs due to their being extraneous.

The first column refers to planetary visibility.

The visibility of Venus. According to what we see in the Lesser Zodiac, Venus should have been visible. Indeed, our solution indicates that it was in perfect vespertine visibility, rising in Cairo at the solar submersion rate of 20 degrees on 7 may 1404 A.D. – in utter darkness. The luminosity of Venus was very high, as usual, equalling –3.5.

The visibility of Mercury. According to the Lesser Zodiac, Mercury was invisible. This is confirmed in our solution – Mercury rose in Cairo at the solar submersion rate of 2 degrees on 7 May 1404, and its luminosity was extremely low, equalling +3.6, which made the planet resemble a dim star. It could therefore neither be seen from Cairo nor from Luxor.

The visibility of Mars. According to the Lesser Zodiac, Mars was visible. This is confirmed in our solution. Its luminosity was rather high – +1.8, which

The Lesser Zodiac of Esna (EM). Verification sheet for the solution of 6-8 May 1404 A. D.							
Planetary visibility	Autumn equinox	Winter solstice	Spring equinox	Summer solstice	Easter	Additional scenes	*Notes*
	S E P	T E M B	E R	Y E A R			
Venus setting in Cairo on 7.05.1404. S. S. = 20°. M = -3.5. *Visible.*	10.09.1403. Sun in Virgo.	10.12.1404. Sun in Sagittarius.	12.03.1404. Sun in Pisces.	11.06.1404. Sun in Gemini.	8.05.1404. The 40th day after the Christian Easter (Ascension).	On 6.01.1404, the day of the Baptism feast, there was a total of four planets in Capricorn – Saturn, Jupiter, Venus and Mercury. Saturn was in vespertine visibility – large figure. Other figures were obscured by the sunshine – small figures.	Interpretation code EMS. The Passover Full Moon according to the Gaussian formulae 27 March 1404. The Passover Full Moon according to the Paschalia 29 March 1404. The Easter according to the Paschalia 30 March 1404.
Mercury rising in Cairo on 7.05.1404. S. S. = 2°. M = +3.6. *Invisible.*	Venus in Leo. S. S. = 20°.	Venus in Scorpio, matutinal visibility. S. S. = 13°. M = -3.4.	Venus in Pisces.	Venus in Gemini.	7.05.1404. The 40th day after the Judaic Passover, estimated according to the Christian Paschalia.	⊕	$\varnothing_{ref}$ = 8° + + + + + + +
Mars setting in Cairo on 7.05.1404. S. S. = 30°. M = +1.8. *Visible.*	Mercury in Virgo.	Mercury in Sagittarius, vespertine visibility. S. S. = 12°. M = +0.4.	Mercury in Pisces.	Mercury in Taurus (1.72).	=> The EM zodiac contains the transcribed day of the Ascension feast.		
⊕	Mars in Capricorn – too far away.	Jupiter in Sagittarius, vespertine visibility. S. S. = 19°. M = -1.4.	Jupiter in Capricorn (9.55).	Mars at the cusp of Gemini and Cancer (3.07).	⊕		
	Jupiter in Sagittarius – too far away. Saturn in Capricorn – too far away.	Mars in Pisces – too far away.	Saturn at the cusp of Capricorn and Aquarius (9.94).	Jupiter in Capricorn – too far away.			
	⊕	Saturn in Capricorn. M = +0.1.	⊕	Saturn is in Aquarius – too far away.			
		S. S. indicated for Cairo in every instant.		⊕			
		⊕					

Fig. 17.50. The verification table for the complete solution of the Lesser Zodiac from Esna (EM) – 6-8 May 1404 A.D. Abbreviations used: S. S. – solar submersion rate transcribed in arc degrees (see CHRON3, Chapter 16:7, Step 3-B); M – planetary luminosity; a fraction between 0 and 12 in parentheses is the calculated position of a planet on the "constellation scale", qv in CHRON3, Chapter 16:10. Bottom right – the result of comparing the solution with the zodiac as well as the average distance between planets and their "best points", qv in CHRON3, Chapter 16:11 and 16:14.

corresponds to the luminosity of the stars of the second magnitude. On 7 May 1404 Mars was in Gemini, 10 degrees further away from the Sun than Venus, – Mars set under the horizon when the solar submersion rate equalled circa 30 degrees, at night, that is, and therefore visible perfectly well.

We draw a plus sign in the first column of the verification table.

The second column is the secondary horoscope of autumn equinox.

As above, we shall select a September year that corresponds to our solution; it is the one that began in September 1403 A.D. and ended in August 1404 A.D. The autumn equinox day fell on 10 September 1403 A.D., qv in Annex 5. However, discrepancy rates of 5-6 days were normal for the estimation of solstice and equinox days in mediaeval astronomy, qv above.

Let us cite planetary positions on the ecliptic for 10 September 1403.

The first row of figures refers to degrees of longitude on the ecliptic J2000, whereas the second row indicates the position of the planet on the "constellation scale", qv in CHRON3, Chapter 16:10.

Julian day (JD) = 2233756.00
Year/month/date = 1403/9/10

Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
183.7	114.8	313.9	281.2	319.2	148.5	204.2
5.22	2.87	9.44	8.42	9.63	4.16	5.72
Virgo	Gemini	Capricorn	Sagitt.	Capricorn	Leo	Virgo

Thus, the Sun was in Virgo, with no other planets but Venus and Mercury anywhere near.

Let us now recollect the secondary horoscope of autumn equinox in the Lesser Zodiac, and the corollary that this horoscope had led us to.

The only planets we can see in the surviving part of the autumn equinox horoscope in the Lesser Zodiac are Mercury and Venus. Mars is in between Cancer and Leo, and also can be part of this secondary horoscope. However, it may just as well relate to the secondary horoscope of summer solstice. Some bright planet was in Leo on the day of autumn equinox. The part of the horoscope from the constellations of Virgo and Libra has not survived; it may have included some planets.

Indeed, according to our solution, Venus was in Leo on the day of autumn equinox and shone the brightest. The correlation will be complete if Mars winds up in Cancer or close thereto in the secondary horoscope of summer solstice – we shall witness this to be the case below.

Therefore, we must draw a plus sign in the second column as well.

The third column corresponds to the secondary horoscope of winter solstice.

The winter solstice day would fall over 10 December 1403 in that epoch, qv in Annex 5. One should account for the possible discrepancy of 5-6 days, qv above.

Let us cite the planetary positions on the ecliptic for 10 December 1403. The indications are as above.

Julian day (JD) = 2233847.00
Year/month/date = 1403/12/10

Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
275.1	224.5	317.3	296.2	362.3	261.2	290.9
8.25	6.43	9.56	8.85	11.39	7.82	8.69
Sagitt.	Libra	Capricorn	Sagitt.	Pisces	Scorpio	Sagitt.

The Sun was in Sagittarius, in conjunction with Mercury and Jupiter (both planets were in vespertine visibility). Venus was on the other side of the sun, in matutinal visibility. It was located in the neighbouring constellation of Scorpio, just 5 degrees away from the boundary between the two constellations. All three planets were visible that day. Also, Saturn was in the nearby constellation of Capricorn; however, the distance between the planet and the Sun was considerable – 42 degrees. Jupiter and Mercury ended up on the same side of the Sun, two times closer to the luminary – at the distance of 21 and 15 degrees on the ecliptic, respectively. All the other planets were even further away from the Sun than Saturn. Therefore, one could find three planets near the Sun that day – Venus, Mercury and Jupiter.

Let us now remind the readers of the corollary we made after analysing the secondary horoscope of winter solstice from the Lesser Zodiac.

Mercury, Venus and another planet (most likely, Jupiter) should be in Sagittarius or close nearby in the secondary horoscope of winter solstice. Also, some

planets may have been in Scorpio, or Sagittarius on the side of Scorpio – sadly, this part of the zodiac is destroyed.

The correspondence between the solution and the secondary horoscope is complete; we shall therefore draw a plus sign in the third column as well.

The fourth column refers to the secondary horoscope of spring equinox.

Vernal equinox fell on 12 March in 1404 A.D., qv in Annex 5. We should also allow for a possible error in the estimation of the vernal equinox date – some 5-6 days.

Let us specify the planetary positions on the ecliptic for 12 March 1404. The indications remain as above.

Julian day (JD) = 2233940.00
Year/month/date = 1404/3/12

Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
368.9	380.8	327.9	317.0	62.4	377.6	365.7
11.56	11.86	9.94	9.55	1.28	11.78	11.48
Pisces	Pisces	Capr/Aqua	Capr.	Taurus	Pisces	Pisces

The Sun was in Pisces on the date in question, with no other planets nearby except for Venus and Mercury (as well as the Moon, which is absent from secondary horoscopes of the Lesser Zodiac).

Let us now consider the secondary horoscope of spring equinox in the Lesser Zodiac and reiterate our corollary in re this horoscope.

Apart from Mercury and Venus, we see another planet in Capricorn (or at the cusp of Capricorn and Sagittarius). The position of Mercury is specified in either Pisces or Aquarius.

We see a good correspondence with our solution. Mercury was indeed in Pisces, and there was a very bright planet in Capricorn those days – Jupiter. There were no other planets but Mercury and Venus near the Sun.

The only thing that strikes us as odd is the absence of Saturn from this secondary horoscope, seeing as how Jupiter is present, and it was further away from Pisces. But the very artwork of the Lesser Zodiac makes it clear that the author had his own reasons to specify just a single extra planet in the secondary horoscope of vernal equinox in Capricorn. It is Jupiter in our solution. The author of the Lesser Zodiac had to draw a symbol of spring equinox equipped with a transposition symbol in between Capricorn and Sagittarius in order to make it feasible. We know nothing of the author's motivation; the situation is really a peculiar one, and we see nothing of the kind in any other Egyptian zodiac. We are therefore unlikely to learn why the author would include Jupiter in this horoscope and not Saturn. At any rate, Saturn had been far enough from Pisces, and its absence of the secondary horoscope gives us no reason to discard the solution.

We shall therefore draw a plus sign in the fourth column as well.

The fifth column refers to the secondary horoscope of summer solstice.

Summer solstice fell on 11 June in 1404. Planetary positions on the ecliptic were as follows:

Julian day (JD) = 2234031.00
Year/month/date = 1404/6/11

Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
96.8	137.6	331.8	324.7	120.4	128.6	78.8
2.25	3.76	10.13	9.83	3.07	3.40	1.72
Gemini	Cancer	Aqua	Capr.	Can/Gem	Gemini	Taurus

The Sun was in Gemini, accompanied by its usual entourage of Venus in Gemini and Mercury in the nearby Taurus. Apart from that, we find Mars at the cusp of Gemini and Cancer. There were no other planets on the celestial sphere. We don't count the Moon, since its symbols are altogether absent from the secondary zodiacs of the Lesser Horoscope.

Let us now remind the reader of the secondary horoscope of summer solstice in the Lesser Zodiac.

Apart from the minimal horoscope of Venus and Mercury, we see Mars in the vicinity of Gemini – either in the constellation, or at the cusp of Gemini and Cancer, if the nearby warrior with a sword also comes from this horoscope.

As we witnessed above, the warrior with the sword wasn't included in the secondary horoscope of autumn equinox; it must therefore pertain to the secondary horoscope of summer solstice. Therefore, Mars in this horoscope should indeed be at the cusp of Gemini and Cancer.

We see ideal correspondence with our solution;

we shall therefore draw a plus sign in the fifth column of the verification table.

The sixth column represents the symbolic reference to Easter and the Passover Full Moon. Both enjoy a great deal of attention in the Lesser Zodiac. We discuss this in detail above, see CHRON3, Chapter 15:9.1. Let us emphasise that the Lesser Zodiac describes the feast of Passover as a *resurrection celebration*, which concurs with the Christian concept of Easter.

The symbolic description of the Passover full moon and the Christian Easter feast is concentrated in the bottom row of the Lesser Zodiac, underneath the figures of Aries and Taurus from the central row – right where one would expect to find Easter, which is a vernal feast celebrated when the Sun is in Aries or close nearby.

In the coloured version of the Lesser Zodiac the scene that symbolises Easter is highlighted green. It includes references to the birth of the Passover moon and the fact that it attains fullness on the 15th day, as well as the symbol of the dead Osiris (apparently, Christ) in coffin before resurrection, and, finally, the symbol of the weeklong resurrection feast. This symbolic scene was studied in detail, qv in CHRON3, Chapter 15:9.1.

The first astronomical vernal full moon of 1404 as calculated by Gaussian formulae fell on 27 March. However, according to the Paschalia, the first calendar full moon fell on 29 March that spring – the day that coincided with the Judaic Passover according to the Christian Paschalia, qv in [BR]:1, while the actual Easter day fell on the 30 March. Therefore, 8 May 1404, which is the day of our solution, had been the fortieth day after the Christian Easter, whereas 7 May 1404, another date covered by our solution, is the fortieth day after the Judaic Passover as defined by the Christian Paschalia.

However, we instantly recollect that the Orthodox Church celebrates Easter on the 40th day after Passover; therefore, the date transcribed in the Lesser Zodiac refers to Passover in 1404. It becomes perfectly clear why there is so much Easter symbolism in the Lesser Zodiac.

And so, we draw another plus sign in the 6th column of the verification table, since the date that we come up with corresponds to the description of Easter that we see in the Lesser Zodiac ideally. However, the

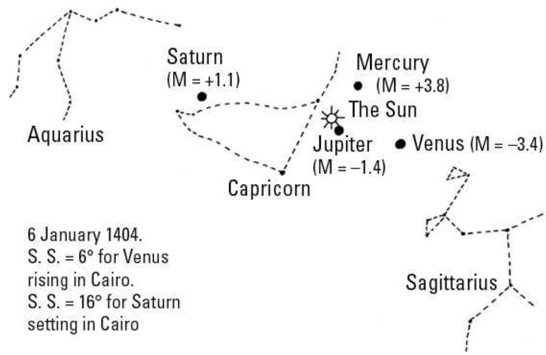


Fig. 17.51. The conjunction of four planets (Saturn, Mercury, Jupiter and Venus) as well as the Sun in Capricorn on 6 January 1404, on the Christian feast of the Baptism, which is in close relation with the figure of John the Baptist. Nearby we find the Aquarius constellation; it apparently used to be a symbol of John the Baptist in Egyptian zodiacs. Saturn was in good vespertine visibility. The visibility of Venus is unlikely, since it had risen at the solar submersion rate of a mere 6 degrees. Jupiter and Mercury were completely lost due to bright sunshine – therefore, the only planet out of four whose visibility was good had been Saturn. Calculated in Turbo-Sky.

abovementioned suspicion that the auxiliary scene with four planets in Capricorn next to the Sun in the central row of the Lesser Zodiac is related to one of the holiest days in the Christian calendar – the Epiphany, a feast that falls on 6 January in the Julian calendar, when the Sun is in Capricorn. The neighbouring constellation of Aquarius is more likely to symbolise John the Baptist in Egyptian zodiacs, as we have already mentioned above. The feast of Epiphany is directly linked to the name of John the Baptist, since it commemorates the baptism of Jesus Christ.

Let us consider the situation in Capricorn on 6 January 1404 (the Epiphany feast). Do we find four planets right next to the Sun? The answer is in the positive.

The seventh column contains the auxiliary scene between Aquarius and Capricorn.

The celestial sphere in the vicinity of Capricorn on 6 January 1404 is represented schematically in fig. 17.51. We see a total of four planets in Capricorn that day, right next to the Sun – Saturn, Venus, Mercury and Jupiter; a total of four. The remaining planets were at a considerable distance from Capricorn that day – Mars in Pisces and the Moon in Virgo.

The only planet of four found in Capricorn had

been in good visibility – Saturn. It had set on 6 January 1404 when the solar submersion rate in Cairo equalled 16 degrees – in complete darkness, that is. Bear in mind that the brightest of stars can be seen when the Sun sets by 7-8 degrees. The night begins when the Sun sets by 18 degrees ([393], page 16). The luminosity of Saturn equalled 1.1 on the date under study, making it as bright as stars of the first magnitude. Saturn was therefore visible perfectly well at dusk and early in the night.

Other planets in Capricorn (Mercury, Jupiter and Venus) were obscured by the nearby Sun, qv in fig. 17.51. Jupiter was right next to the Sun, likewise Mercury, which also possessed a very low luminosity that day – +3.4. The visibility of either planet is therefore out of the question. Venus is unlikely to have been visible, save for a few moments before the very sunrise, perhaps, at the solar submersion rate of 6 degrees. The sky was too bright for any star to be visible. The luminosity of Venus had been exceptionally high (–3.4), which means one could observe it, but only for a very brief period of time.

This scene concurs perfectly to the "scene with snakes and boats" between Aquarius and Capricorn, where all three planets, including the "group of Mercury" and Venus, are drawn as tiny figures, whilst the fourth one is exceptionally large – this should represent the fact that three of the planets were obscured by the Sun, with only Saturn visible well. See the coloured version of the Lesser Zodiac, where the entire "scene with snakes" between Aquarius and Capricorn in the central row is highlighted green. An analysis of its symbolism can be seen above, in CHRON3, Chapter 17:6.5.3.

Let us cite exact positions of the planets on the ecliptic for 5-7 January 1404. We shall consider three consecutive days covering the actual date of the Epiphany (6 January) in order to make the directions of planetary motion visible.

Julian day (JD) = 2233873.00
Year/month/date = 1404/1/5

Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
301.6	206.9	320.2	302.2	378.9	293.9	303.0
9.00	5.79	9.66	9.02	11.81	8.78	9.05
Capr.	Virgo	Capr.	Capricorn	Pisces	Sagitt.	Capr.

Julian day (JD) = 2233874.00 <Feast of the Epiphany>
Year/month/date = 1404/1/6

Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
302.7	219.6	320.3	302.5	379.5	295.1	301.8
9.04	6.19	9.67	9.03	11.82	8.82	9.01
Capr.	Libra	Capr.	Capricorn	Pisces	Sag/Cap	Capr.

Julian day (JD) = 2233875.00
Year/month/date = 1404/1/7

Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
303.7	232.7	320.4	302.7	380.2	296.4	300.5
9.08	6.81	9.67	9.04	11.84	8.85	8.97
Capr.	Libra	Capr.	Capricorn	Pisces	Sag/Cap	Sag/Cap

And so, we draw a plus sign in the seventh column of the verification table as well, thus making it complete, with a plus sign in every column, qv in fig. 17.50. The solution is therefore an exhaustive one.

We haven't managed to find any other exhaustive solutions for any interpretation of the primary horoscope from the Lesser Zodiac of Esna.

COROLLARY:

The Lesser Zodiac of Esna contains the date of 6-8 May 1404 A.D. – the Easter Day. The best correspondence with the Zodiac was reached on 7 May 1404.

7. THE CORRELATION BETWEEN THE SOLUTION DATES AND THE NEW CHRONOLOGY AS WELL AS OUR RECONSTRUCTION OF HISTORY

We have thus demonstrated that the dates transcribed in the monumental zodiacs from the Egyptian temples near the "Bight of the Kings" carved in stone by the allegedly ancient Egyptians are mediaeval, namely:

1) 22-26 April 1168 A.D. in the Long Zodiac of Dendera;

2) morning of 20 March 1185 A.D. in the Round Zodiac of Dendera;

3) 31 March – 3 April 1394 A.D. in the zodiac from the Greater Temple of Esna;

4) 6-8 May 1404 A.D. in the Zodiac from the Lesser Temple of Esna. The day coincides with the Easter cel-

ebrations, which must be the reason why we find so many Easter symbols in the Lesser Zodiac of Esna.

Thus, the temples of Dendera were consecrated to events that took place at the end of the XII century A.D. The temples of Esna commemorate more recent events dating to the late XIV – early XV century of the new era.

The actual temples are therefore more recent than the dates found in the zodiacs. We are of the opinion that their builders were the Mamelukes, or the keepers of the royal cemetery of the Great Empire. They were the ancient Christian (or Judeo-Christian) temples of "Hellenistic epoch", or the epoch of the Great = "Mongolian" conquest of the XIV and the foundation of the Great = "Mongolian" Empire, whose central part was located between the two great rivers – Volga and Oka, or the Russia of Vladimir and Suzdal ([REC]).

The temples may have been built shortly before the Ottoman conquest of Egypt and the loss of Egypt and the decline of the Mameluke rule, which took place in the XVI century of the New Era.

Let us illustrate in brief. We relate this topic in greater detail in Volumes 5-7 of "Chronology", as well as our books entitled ***A Reconstruction of Global History*** and ***Russia and Rome***.

The Ottoman conquest of the XV-XVI century – which, according to our reconstruction, originated in the centre of the Great Empire, or the Russia of Vladimir and Suzdal, likewise the Great = "Mongolian" conquest that had preceded it. These events reflected a major crisis in the Empire ([REC]). The life of the Great Empire must have undergone some radical shift. The old religion of the Empire, or the initially monolith Christianity, began to transform and fell prey to numerous schisms around this time ([REC]). Nowadays we refer to these events as to the "baptism" of nations, which isn't quite correct.

The Scaligerian version of chronology misdates the baptism of nations to the IV century A.D. and makes it look as though the imperial authorities had abandoned "paganism", or "Hellenism", which was allegedly completely unlike Christianity. According to the New Chronology and our reconstruction of history, this doesn't appear to be the case. First and foremost, the events in question don't date to the IV century of the new era, but rather the XV-XVI century. It is also absolutely crucial that we bear in mind the Christian identity of the hypothetical "Hellenism" or "paganism" of the first Imperial rulers. They revered Christ and celebrated the primary Christian feasts – Easter, Christmas, Annunciation and several others. However, many of the rites dating to the epoch in question that had managed to coexist with Christianity peacefully up until the XV-XVI century were abolished, and, moreover, became subject to severe persecution and utter eradication. They became declared "pagan" and "non-Christian". The possible reasons for a change this drastic were outlined in our work ([REC]). One of the reasons – possibly even the primary reason, may have been the monstrous outbreak of epidemic diseases that wiped out most of the Empire's population at the end of the XIV – beginning of the XV century A.D. As a result, the morals became a lot more austere, with many limitations imposed upon the populace. The limitations were enforced by the Christian church of the Empire, reformed in accordance with what the epoch demanded.

In particular, this manifested as the destruction of the old Christian temples adorned with abolished symbols, forbidden and persecuted by the new authorities. A more ascetic symbolism was introduced; its most extreme form – absolute ban on all graphical representations of people and animals in houses of prayer (mosques) still exists in Islam.

This policy would naturally be introduced with military assistance as well as peacefully. The Ottomans have burnt and pillaged their way through the entire South of the Empire, destroying the old "pagan" temples that they have grown to hate. The ancient imperial rites must have survived the longest where the old imperial graveyard had remained out of everybody's reach until the XVI century, which is when the Ottomans invaded Egypt. This is when the gigantic funereal temples and other constructions of the "Bight of the Kings" on the Nile were destroyed.

However, it is most likely that the Ottomans didn't touch the actual royal sepulchres – furthermore, it is possible that the kings of Russia (Horde) and their kin had been buried on the same graveyard up until the XVII century. The Mamelukes, despite having lost power in Egypt to the Ottomans, continued to protect the royal sepulchres up until the advent of the Europeans at the end of the XVIII century, when the

actual royal cemetery became pillaged. The mummies of the Horde's kings that were hidden in haste by the last keepers of the cemetery were eventually found by the Europeans and taken to the museum of Cairo ([370]). This happened as recently as the second part of the XIX century.

According to our reconstruction, Egypt had been one of the primary religious centres of both ancient Romea (Byzantium) of the X-XIII century and its successor, or the Great = Mongolian Empire of the XIV-XVI century, whose centres were located around Vladimir and Suzdal in Russia, as well as in Istanbul (Constantinople). The cult of the dead Czars (or Khans) was rooted in Egypt.

This may have started with the observation made by the ancients that a corpse doesn't rot in hot sand around these parts due to the hot climate and the extremely low humidity. This makes the valley of the Nile an ideal place for burials.

However, there may have been other reasons. Egypt might turn out the historical homeland of the predecessors of the Great Empire's royal dynasty that had reigned in the XIV-XVI century A.D. The kings would still be buried in the land of their ancestors, even when the capital of the Empire had already been far away from Egypt – first in the Czar-Grad on the Bosporus, and then around Vladimir and Suzdal in Russia.

One way or another, the valley of the Nile was chosen as the optimal site for the royal cemetery in the epoch of the Great Empire. According to our reconstruction, this explains the domination of the funereal theme in the artwork found on many Egyptian monuments.

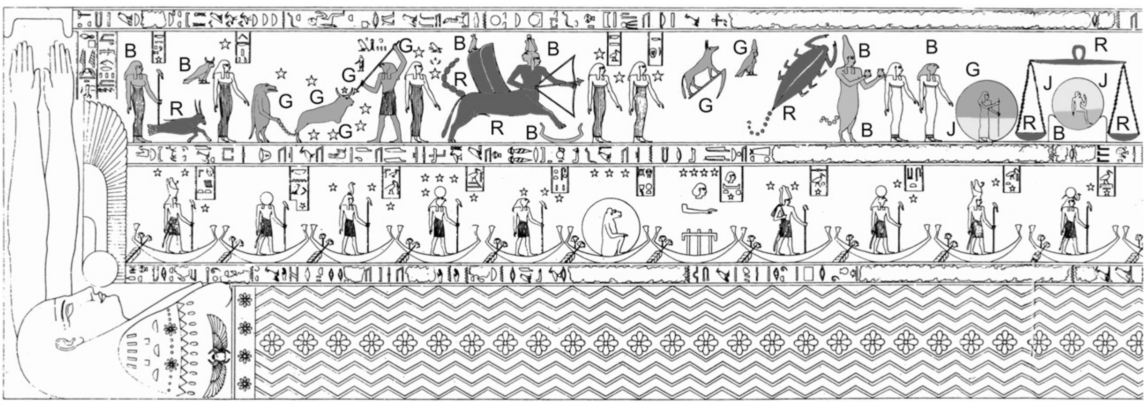


Fig. C1. The Long Zodiac of Dendera (DL) coloured by the authors. The colours are represented by the following codes: *R* for red, *J* for yellow, *B* for blue, *G* for green and *BR* for brown. Zodiacal constellations are coloured red (letter *R*). Yellow (letter *J*) marks the planets of the primary horoscope. The colour blue (letter *B*) refers to secondary horoscopes (symbols of equinoxes and solstices). Green (letter *G*) is the colour of the "procession figures" of the primary horoscope's planets, as well as the additional astronomical symbols and scenes. Circles with two colours (yellow and blue) indicate symbols that can be ascribed to primary and secondary horoscopes simultaneously. Blue parts of red figures are the symbols from secondary horoscopes integrated into the constellation figures or the ten-degree symbols. The latter are painted brown, qv in CHRON3, Chapter 15:2. Ten-degree symbols of each constellation are numbered 1-3. The actual constellation symbol also serves as one of its own three ten-degree symbols. Based on the drawn copy from [1100], A. Vol. IV, Pl. 20. First part of the drawing, qv in CHRON3, Chapter 16:8.

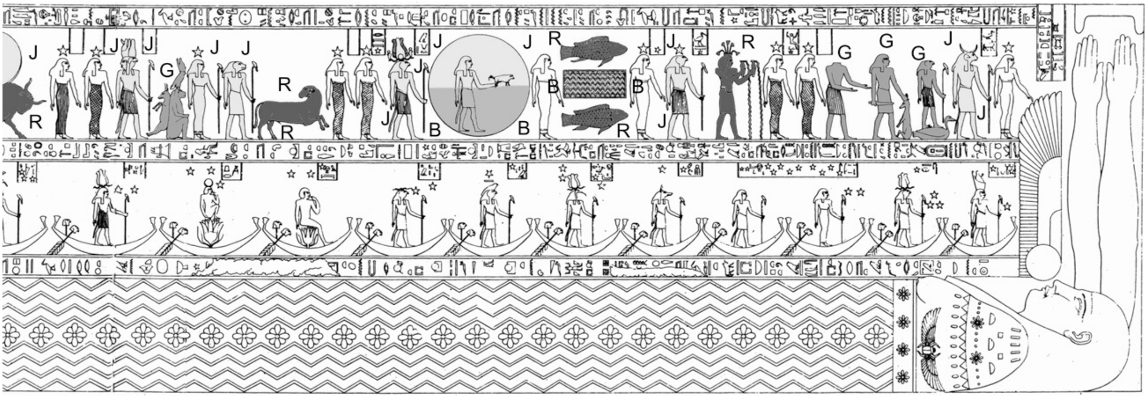


Fig. C2. The coloured version of the Long Zodiac from Dendera (DL). See CHRON3, Chapter 16:8. Second part of the drawing.

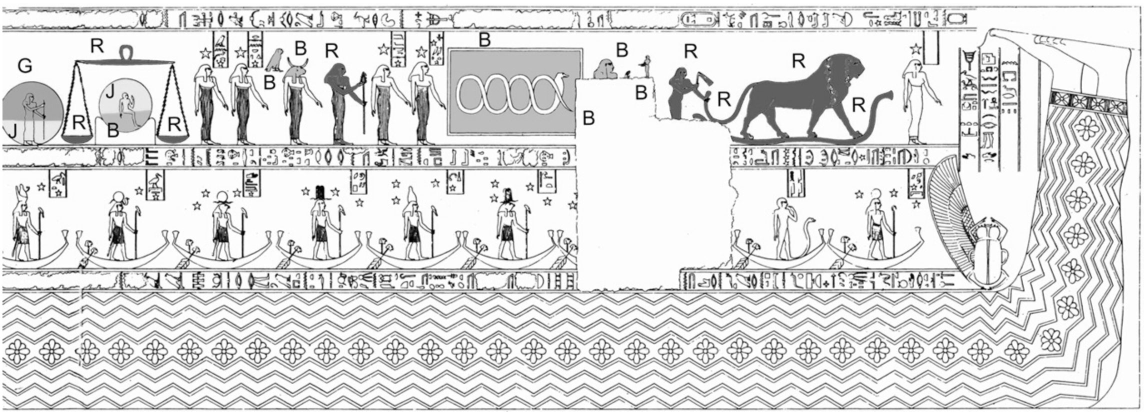


Fig. C3. The coloured version of the Long Zodiac from Dendera (DL). See CHRON3, Chapter 16:8. Third part of the drawing.

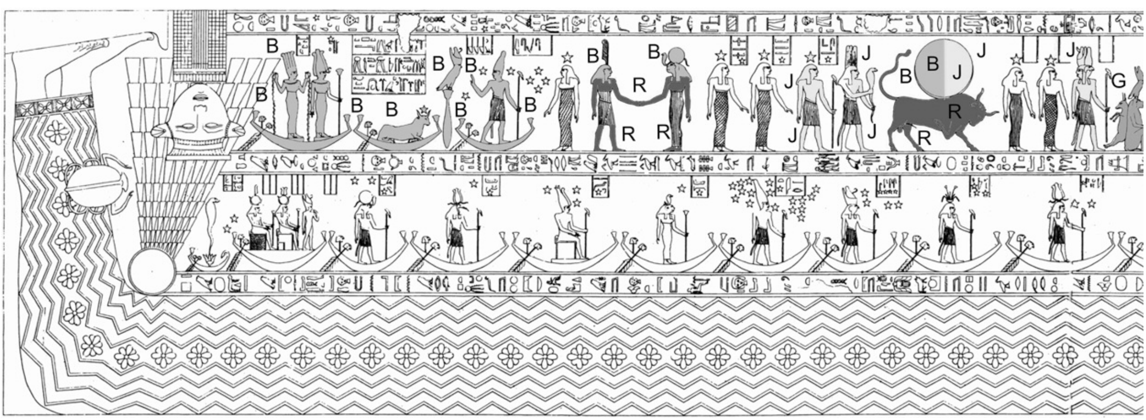


Fig. C4. The coloured version of the Long Zodiac from Dendera (DL). See CHRON3, Chapter 16:8. Fourth part of the drawing.

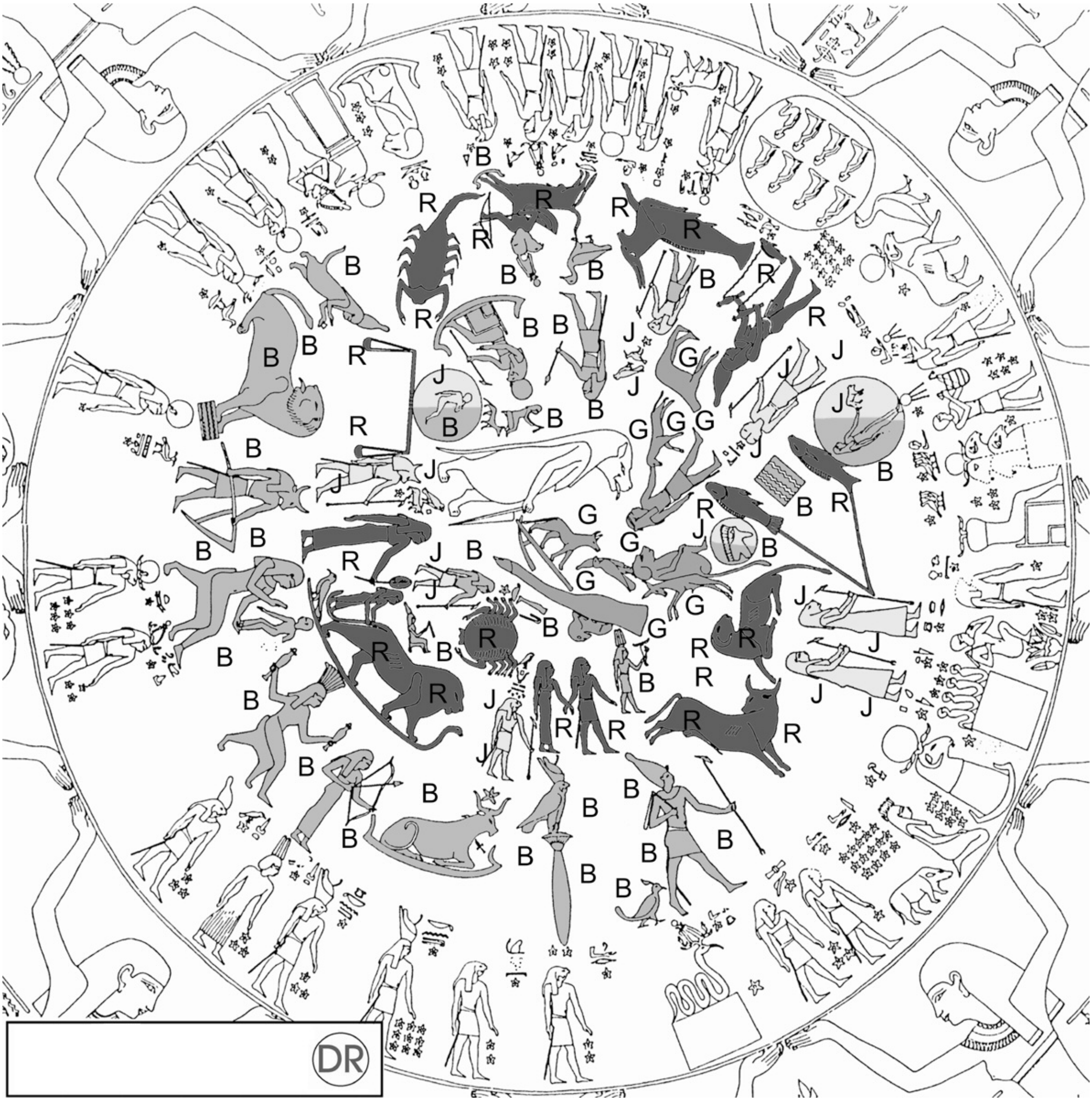


Fig. C5. The coloured version of the Round Zodiac from Dendera (DR). See Chron3, Chapter 16:8. The zodiacal belt is circumscribed by the red line. Outside of the belt one can clearly see the blue belt of secondary horoscope that spans half of the zodiac from one of the sides. Based on the drawn copy from [1062], page 71.

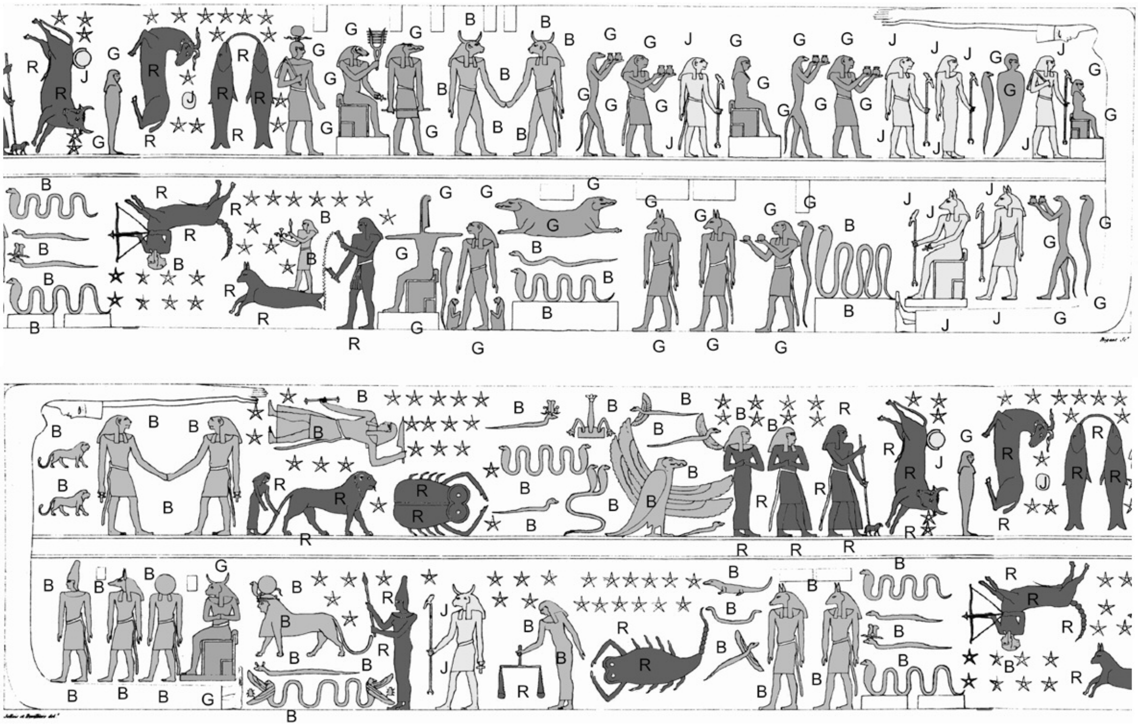


Fig. C6. The coloured version of the Greater Zodiac from Esna (EB). The "doubles" of the primary horoscope's planets are coloured green, likewise the figures from their processions, qv in CHRON3, Chapter 16:8. Based on the drawn copy from [1100], A. Vol. I, Pl. 79.

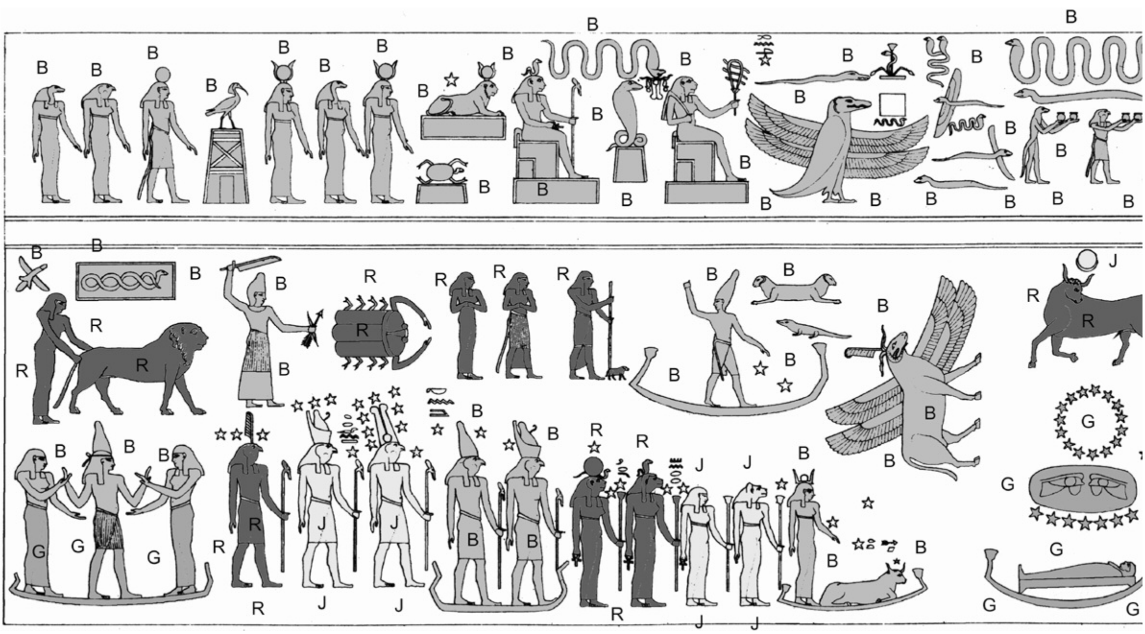


Fig. C7. The coloured version of the Lesser Zodiac from Esna (EM). Part one. Based on the drawn copy from [1100], A. Vol. I, Pl. 87.

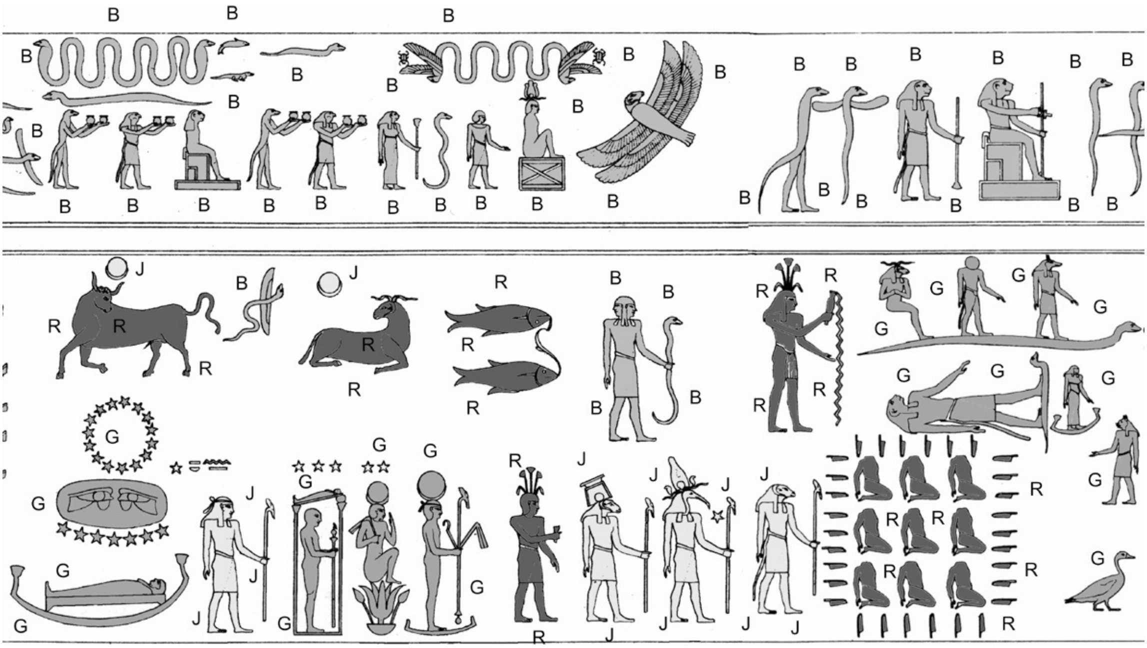


Fig. C8. The coloured version of the Lesser Zodiac from Esna (EM). Part two. Based on the drawn copy from [1100], A. Vol. I, Pl. 87.

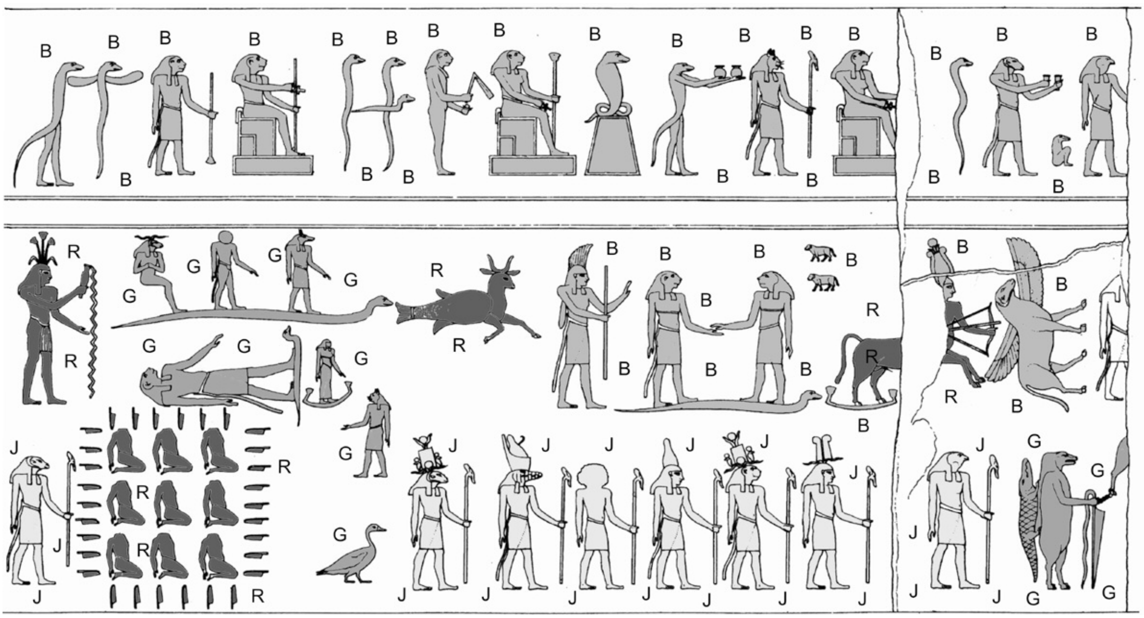


Fig. C9. The coloured version of the Lesser Zodiac from Esna (EM). Part three. Based on the drawn copy from [1100], A. Vol. I, Pl. 87.

CHAPTER 18

Dates in zodiacs discovered inside Egyptian sepulchres

1. THE ATHRIBIS ZODIACS OF FLINDERS PETRIE (AV + AN)

1.1. The decipherment of the primary horoscope. Six options of planetary identification

In Chron3, Chapter 13, we give a detailed account of the zodiacs from Athribis and the previous attempts of their astronomical dating. In fig. 13.9 one sees a drawn copy of these zodiacs. Let us remind the reader that the zodiacs of Athribis are a drawing (possibly a fresco) done on the ceiling of a sepulchral cave in Egypt in a variety of colours. There are two zodiacs there, one under the other; they were discovered by Flinders Petrie, the famous Egyptologist. This happened in 1901, in the vicinity of Athribis, a town in southern Egypt, next to Sohag ([544], Volume 6, page 731). The Athribis zodiacs are therefore occasionally referred to as the zodiacs of Flinders Petrie.

It has to be mentioned that there's an ancient Egyptian temple in Athribis, of the same type as the temples of Dendera ([544]), Volume 6, page 731. It is possible that it contains zodiacs as well, likewise the temple of Dendera. However, we were unfortunate enough to find no detailed descriptions of this temple whatsoever. It would be very interesting to learn whether there are zodiacs in the temple of Athribis, and, should this prove to be the case, to discover the dates transcribed therein. As for the Athribis zodiacs of Flinders Petrie that we have under study, they were discovered in a sepulchral cave and not a temple. These zodiacs are obviously of a sepulchral nature, and contain dates related to the persons buried in the cave.

Attempts to date the Athribis zodiacs astronomically were made in the XIX-XX century by Knobel and Morozov; we discuss them in detail in Chron3, Chapter 13:3. In particular, we demonstrate that both Knobel and Morozov made great allowances in their interpretation of the primary horoscopes from the zodiacs of Athribis; furthermore, the identifications of the primary horoscope's planets that they suggest are most likely to simply be incorrect, since they would identify the same planetary figures from the two zodiacs as two different planets.

We shall therefore begin the interpretation of the symbols from the zodiacs of Athribis from scratch, regardless of the versions suggested in the research of Knobel and Morozov. However, our final interpretation shall prove very close to the one suggested by Flinders Petrie initially.

We shall need more detailed copies of the Athribis

zodiacs than the ones seen in fig. 13.9. Respective drawn copies can be seen in figs. 18.1 and 18.2. Drawn copies and coloured versions of the Athribis zodiacs seen in figs. C10 and C11 shall give the readers an opportunity to follow every detail of our analysis.

Let us begin with our study of the symbols found in the zodiacs from Athribis – figures used for constellations, planets and secondary horoscope symbols. We shall begin with constellations, as usual.

Constellation figures in the zodiacs of Athribis are perfectly easy to understand – all of them are drawn very clearly, and in the correct sequence. We discussed them at sufficient length in Chron3, Chapter 15:1, where we reproduced the drawn copies of all the constellations represented in the zodiacs of Athribis. We shall refrain from reiterations herein; the only thing that needs to be pointed out is the fact that the figure of the woman that holds on to Leo's tail isn't a figure of an "auxiliary Virgo" in Leo, which is the case in most other Egyptian zodiacs, but rather the primary figure of the Virgo constellation. All the constellations are highlighted red in the "coloured versions" of the zodiacs from Athribis, qv in fig. C10.

Now for the planets. All of the primary horoscope's planets, except for the Sun, the Moon and Mercury, are drawn as birds in the zodiacs of Athribis. This was understood by N. A. Morozov perfectly well, but noticed before that, in the works of the Egyptologists. Our analysis also confirms their corollary. The only question is the "role distribution" among the birds, or their respective planetary identifications. We shall get to it below; however, let us first point out the Sun, the Moon, and Mercury – objects that don't look like birds here.

The Sun. In each of the two zodiacs we see a circle that represents the Sun. It is underneath Taurus in the Upper Zodiac, and below the cusp of Capricorn and Aquarius in the Lower.

The Moon. In the Lower Zodiac of Athribis, the Moon is drawn under Sagittarius. A colour copy of the zodiac's respective fragment can be seen in [1215:1], page 22. The moon is drawn as a brick-red circle, with a wide and clearly drawn crescent on its lower perimeter, greenish in colour. The drawing leaves us with no doubts that what we see is the Moon. Nevertheless, bearing the red "solar" colour of the circle with the crescent in mind, we also accounted for the solar identification option in case of this symbol, whereas the simple crescent-less circle would be hypothetically identified as the Moon. However, we didn't come up with a single solution pair for the zodiacs of Athribis, qv below. Thus, we find that the Moon in the Lower Zodiac is in Sagittarius.

It has to be pointed out that the circle in Libra with a bird inside it, as seen in both zodiacs of Athribis, isn't the Moon in the primary horoscope, but rather the Passover full moon. The lunar disc that reflects the light of the solar bird is drawn as a circle, as it was discussed in Chron3, Chapter 15:9.1. We shall come back to this issue below. According to the coloured fragment from [1215:1], page 22, the circle's colour is brick red, and the bird inside it is yellow.

In the Upper Zodiac of Athribis the crescent is right underneath Gemini. The drawn copy makes it obvious that the crescent was extended into a full circle, as is the case with the Lower Zodiac. The artwork of the Upper Zodiac is damaged in this part – nevertheless, a comparison with the Lower Zodiac makes it obvious that we have a similar symbol in front of us. Therefore, the Upper Zodiac's Moon is in Gemini.

Mercury. Both zodiacs contain a lone male figure with a canonical planetary rod. There are no other such figures anywhere in the zodiacs of Athribis. We shall disregards the perimeter strip of secondary horoscopes that will be considered below (it also contains a figure with a rod).

The man with a rod is underneath Taurus in the Upper Zodiac, and below Pisces in the Lower. His figure has two faces, which is very obvious in the Lower Zodiac. The figure in the Upper Zodiac is damaged, with a part of the head and an arm missing.

The symbol of a two-faced man with a planetary rod is already well familiar to us – it represents Mercury in the primary horoscope, qv in Chron3, Chapter 15:4.9. Therefore, Mercury in the Upper Zodiac of Athribis is in Taurus.

In the Lower Zodiac of Athribis Mercury is most likely to be drawn in Pisces. We must note that Mercury is included in the agglomeration of four planetary figures huddled together under the constellation triad of Capricorn, Aquarius and Pisces. It is therefore possible that the entire group, including Mercury, is located in the area of the three constellations specified above, possibly excluding Pisces. Strictly speak-

Fig. 18.1. The Upper Zodiac of Athribis (AV). A magnified drawn copy. Fragment of an illustration from [544], Volume 6, page 730.

ing, this implies that we have to consider the possibility of Mercury being in Aquarius and even in Capricorn. We shall refrain from it for the time being, and assume that Mercury is in Pisces, which is the sign we find right above it. Below we shall also consider the option with the random distribution of the four planets across Capricorn, Aquarius and Pisces.

Thus, Mercury in the Lower Zodiac can be found in Pisces.

We must now locate just four planets from the primary horoscope, namely, Saturn, Jupiter, Venus and Mars. It has to be pointed out that there are four fantasy birds underneath the constellation figures in both zodiacs, four on each – some of them have horns, others are drawn with serpent tails etc. These four birds obviously stand for the remaining four figures of the primary horoscope. Knobel and Morozov adhered to this opinion, so we haven't given the reader any new information so far.

Let us carry on. It turns out that the sets of four fantasy birds as found in both zodiacs coincide. In other words, there is an obvious correspondence between the four fantasy birds from the Upper Zodiac and a similar four from the Lower, with identical birds standing for the same planet. It is quite unambiguous, qv in fig. 18.3.

Indeed:

1) In the Upper Zodiac of Athribis we see a bird with a crescent-like horns on its head underneath Pisces, whereas an identical bird in the Lower Zodiac is under Gemini. There are no other birds with a similar horn shape anywhere in the zodiacs of Athribis. The horns are the only distinctive characteristic possessed by these birds; they must therefore represent

Fig. 18.2. The Lower Zodiac of Athribis (AN). A magnified drawn copy. Fragment of an illustration from [544], Volume 6, page 730.

the same symbol that we encounter once in each of the Athribis zodiacs. It is therefore the same planet; let us refer to it as to "planet #1" for the time being.

2) In the Upper Zodiac we see a horned bird over Cancer. Its horns are vertical, long and slightly curved, like those of an antelope. In the Lower Zodiac, there's a spitting image of this bird under Aquarius and Pisces. There are no other birds with such horns anywhere in the Athribis zodiacs. The birds also possess no other special characteristics, which means we have two representations of the same symbol in front of us, drawn once in each of the zodiacs, or the same planet. Let us call it "planet #2" for the time being.

3) We see a bird with a serpent's tail and a large beak, its wings folded, underneath Capricorn in the Upper Zodiac. There is a double of this bird in the Lower Zodiac – complete with a serpent's tail, large beak and folded wings. This bird is also located underneath Capricorn. There are no other birds of this kind in the Zodiacs of Athribis. We see one bird with a similar tail in the Lower Zodiac, but its wings are spread, and it has a snake instead of a beak, and therefore symbolises something else. The birds we find underneath Capricorn in both zodiacs of Athribis coincide in all of their characteristics, and therefore stand for the same planet, found once in each of the two zodiacs. We shall dub it "planet #3" for the time being.

4) There is a single bird left to identify in each of

the two zodiacs. It is underneath Taurus in the Upper Zodiac, next to the Sun, and underneath Leo in the Lower Zodiac. However, a full identification is a non-option due to the fact that the bird from the Upper Zodiac is damaged to a great extent, with nothing left but the legs and the right wing. All we can say about the bird is that its wings are spread. The surviving bird under Leo in the Lower Zodiac is in good condition; it has the tail and the head of a serpent and spread wings. There is no other bird that looks like this anywhere amidst the whole and undamaged bird figures found in the Upper Zodiac, and it can only correspond to the semi-obliterated bird under Taurus. The correlation is obvious if we are to consider the spread wings of both figures; there are no other options for this pair. We have therefore found the symbol of the last missing planet from the primary horoscope of both zodiacs; we shall call it "planet #4" for the time being.

There are no more fantasy birds in the constellation row on the Athribis zodiacs. There's a perfectly ordinary bird without anything in the way of horns, serpent tails and the like. It looks the same in both zodiacs, and we find it in the circle over Libra. However, we already know that it stands for the Passover full moon. We discussed this symbol in detail above (see Chron3, Chapter 15:9.1). It is part of the auxiliary astronomical scene at the very bottom of both zodiacs. The entire scene is highlighted green in the coloured versions of the zodiacs. The bird in the circle is also drawn over Libra, whereas all the other figures in the zodiacs of Athribis are below the respective zodiacal constellations. This observation confirms our corollary that the bird in the circle over Libra isn't part of the primary horoscope in this case.

We are therefore left with the following picture of the primary horoscope in both zodiacs of Athribis. See the accordingly coloured zodiacs.

Upper Zodiac:
Planet #3 is in Capricorn,
Planet #1 is in Pisces,
Planet #4, the Sun and Mercury are in Taurus,
The Moon is in Gemini,
Planet #2 is in either Gemini or Cancer.
Lower Zodiac:
Planet #3 is in Capricorn.
The Sun is in either Capricorn or Aquarius; it is drawn at the cusp of the two constellations.
Planet #2 is in either Aquarius or Pisces.
Mercury is in Pisces.
Planet #1 is in Gemini.
Planet #4 is in Leo.
The Moon is in Sagittarius.

It has to be pointed out that all the planets in the Athribis Zodiacs are located underneath the corresponding constellation signs. Therefore, whenever a planetary figure winds up in between two constellations, one of which is above in the drawing, and the other below, there is no room for confusion. Nevertheless, we would consider both constellations as possible locations of planets in such cases.

Now let us sort through all possible identification options of the four planets – Saturn, Jupiter, Mars and Venus, and the four fantasy birds of the Athribis zodiacs. We shall calculate all the astronomical solutions for each of them with the aid of a computer and see whether any of the solutions might contain a pair of dates for both zodiacs that would correspond to the average human lifespan.

Let us explicate that the Zodiacs of Athribis are most likely to contain the dates of birth and death of the person buried in the cavern – or, possibly, the demise dates of close relatives buried together. However,

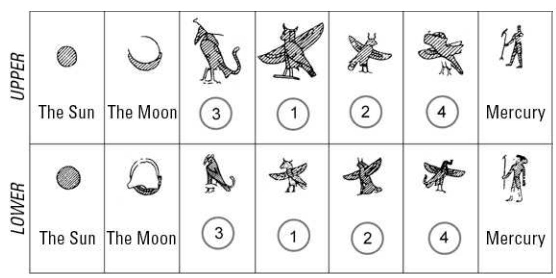


Fig. 18.3. Undisputed mutual correspondence between the planetary figures from the respective primary horoscopes of the Upper and the Lower Zodiac of Athribis (AV and AN). The Sun, the Moon and Mercury are the only figures we can identify instantly. The other four planets (Saturn, Jupiter, Mercury and Venus) look like fantasy birds with horns, tails and beaks of different shapes. We used circles with numbers 1, 2, 3 and 4 for referring to them. Which planet is represented by which bird exactly can only be estimated from astronomical computations.

in the latter case the interval between the two dates can't be all that great, either – it will be less than a century, which is the maximal order of magnitude possible in this case.

The choice of options for identifying the four fantasy birds from the Athribis zodiacs as planets shall be facilitated if we are to remember that Venus is never further away from the Sun than 40 degrees, and there cannot be more than two full zodiacal constellations between Venus and the Sun. In that case, none of the four planetary figures but that of planet #2 can represent Venus. Indeed:

There are three full constellations between the Sun and planet #1 in the Lower Zodiac at least, which means it cannot be Venus.

There are three full constellations between the Sun and planet #3 in the Upper Zodiac (Aries, Aquarius and Pisces). Therefore, this planet isn't Venus, either.

There are four full constellations at least between the Sun and planet #4 in the Lower Zodiac. This planet also cannot be identified as Venus.

Finally, planet #2 isn't separated from the Sun by more than one full constellation in any of the two zodiacs. The Sun is in Taurus in the Upper Zodiac, whereas planet #2 is in Cancer – the only full constellation between the two is Gemini. In the Lower Zodiac, the two are right next to each other – in Capricorn/Aquarius. Therefore, only planet #2 can be identified as Venus.

We have therefore discovered Venus in the zodiacs of Athribis. It is the bird with tall horns whose shape resembles an antelope's horns. None of the more "horrifying" birds with serpent parts became identified as Venus, which is only logical – it would be really odd if Venus turned out to be represented by a bird with the tail of a serpent, or one with a large menacing beak. Planet #2 that became identified as Venus, on the other hand, is a bird that looks peaceful and even placid.

Interpretation option code	*Jupiter*	*Saturn*	*Mars*
A1	1	3	4
A2	1	4	3
A3	3	1	4
A4	3	4	1
A5	4	1	3
A6	4	3	1

Table 18.1. Possible interpretation options for the primary horoscopes in the Zodiacs of Athribis.

The three planetary birds that remain unidentified will have to be discovered by simple calculus. Readers familiar with combinatorial analysis will instantly realise that we shall have to sort through six possible identification options for the three planetary birds (Jupiter, Saturn and Mars). Let us briefly indicate them as A1, … A6. All of them are represented in Table 18.1. Let us explain its construction. The table has six rows corresponding to number of possible options. The rows contain the numbers of planets identified as Jupiter, Saturn and Mars, corresponding to one of the versions or another.

1.2. Secondary horoscopes and additional scenes in the zodiacs from Athribis

Symbols of secondary horoscopes in the zodiacs of Athribis are concentrated in the strip of figures that encloses the entire drawing, for the sole exception of the additional scene with the Passover Moon. This strip is highlighted in blue in the coloured versions of the zodiac. Its symbolism was already discussed above, in CHRON3, Chapter 15.

Primarily, the strip consists of solstice and equinox symbols. In its upper part, over Gemini from the Upper Zodiac, we see a four-faced figure with a planetary rod. However, such figures rank with autumn and equinox symbols and have nothing in common with secondary horoscope's planets, qv in CHRON3, Chapter 15:8.

However, there is a single secondary horoscope with planetary figures – the summer solstice horoscope of the Lower Zodiac. We already studied this secondary horoscope attentively in CHRON3, Chapter 15:5.3, and have only recollected its contents briefly herein, qv in fig. 15.55 above.

The horoscope is quite spectacular, since it contains a total of five birds with human faces. They are likely to stand for Mercury, Venus, Jupiter, Saturn and Mars congregated around the Sun. Don't forget that in the zodiacs from Athribis planets were most often drawn as birds. As for the Sun, it looks differently

here – namely, as a figure of a man whose arm is raised into the air, which is a standard representation of the Sun during summer solstice in Egyptian zodiacs, qv in CHRON3, Chapter 15.8. The Moon is apparently absent from this secondary horoscope, since it is always accompanied by the figure of a crescent or a circle in Egyptian zodiacs; however, we see none of the above here.

Two planetary birds can be seen on one side of the Sun as described above, and three more on the other. Next to the two planetary birds on the left we see inscriptions that were read as Meri-Hor and Ab-Ne-Mano by H. Brugsch ([544], Volume 6, page 729). Furthermore, we must note that the leftmost bird over the head of the Sun has a female face; it must therefore stand for Venus. The entire secondary horoscope is located on the opposite of the Gemini figure in the Lower Zodiac; in other words, right where is should be in Egyptian zodiacs, qv in CHRON3, Chapter 15:8. Bear in mind that the Sun is in Gemini on the day of Summer Solstice.

What we see here indicates that Mercury, Venus, Jupiter, Saturn and Mars must have been in Gemini on the day of summer solstice, or close thereto. Two planets out of five, including Venus (the bird with a female face) are drawn "over the head of the Sun" in the zodiac, which is probably an indication of matutinal disposition. Other three planets of the secondary horoscope are under the feet of the Sun, or follow a vespertine rising pattern. We must explicate that planets in matutinal visibility rise before the Sun, or move in front of it – over its head, figuratively speaking. On the other hand, the planets visible at dusk follow the Sun, and are located under its feet, in a way.

Thus, the secondary horoscope of summer solstice in the Lower Zodiac of Athribis in its ideal form is as follows:

On the day of summer solstice, five planets (Mercury, Venus, Jupiter, Saturn and Mars) had to be in Gemini or close nearby. Two planets out of five are drawn "over the head of the Sun" – on the side of matutinal visibility, whereas three others are "under the feet of the Sun", or on vespertine visibility side. Venus was further away from the Sun than the second planet right next to it.

We have found no other secondary horoscopes in the zodiacs of Athribis. However, apart from the usual solstice and equinox symbols that the surrounding strip of zodiacal symbols consists of, which are quite useless for the verification of solutions, as we mentioned above, there is nevertheless a symbol here that may prove informative.

Mark the scene of the "meeting over Leo" drawn in the part of the perimeter strip that we see on the left of the Upper Zodiac. We see a lion (or a lioness) with a human head – possibly, a female figure. On its back there are two standing male figures holding hands, one of them has two faces. . It must be Mercury – after all, we often find it drawn as a two-faced man. On the other hand, a lion or a lioness with a human head would often refer to Venus in Leo or somewhere close nearby, as we have witnessed on numerous occasions (see CHRON3, Chapter 15:4.8 in re the symbols of Venus in Egyptian zodiacs).

Therefore, the entire symbolic scene above is most likely to refer to the "meeting" (conjunction) of Mercury and some other "male" planet in Leo, also accompanied by Venus.

Naturally, the interpretation option of this Egyptian symbol that we suggest should neither be considered finite nor the only one possible. Nevertheless, once we attain an exhaustive solution of the Athribis zodiacs, the symbol's meaning shall become obvious. Let us point out that the two-faced figure of Mercury that we find here is an eloquent enough indication that the scene is dedicated to some planetary configuration that includes Mercury in Leo.

1.3. Results of calculations including six options with rigid planetary order

Now let us cite the results of computer calculations that involved all of the six possible interpretation versions (A1-A6) of the primary horoscopes from the zodiacs of Athribis. The results can be seen in table 18.2. The corresponding data files for the Horos program are given in Annex 4 indicated AN1 … AN6 for the Lower Zodiac and AV1 … AV6 for the Upper. Twelve files altogether – six for each of the two zodiacs from Athribis. As usual, the only solutions we consider involve the same planetary disposition order on the ecliptic as given in the zodiacs. Exceptions were only made for the planets found at the distance of 1 degree or less from each other, in which case

their order would become impossible to estimate with the naked eye. The solution search interval starts with 500 B.C. and ends with 2000 A.D.

Let us cite exact dates for all the solutions from the table. "Average deviation" shall refer to the "average deviation from the best points".

IDENTIFICATION A1. *Upper Zodiac:* (year –244, 21-23 May, average deviation equals 14 degrees); (1962, 21-22 May, average deviation equals 13 degrees). *Lower Zodiac:* no solutions.

IDENTIFICATION A2. *Upper Zodiac:* (year 408, 13 May, average deviation equals 17 degrees). *Lower Zodiac:* (year 1125, 2 February, average deviation equals 11 degrees).

IDENTIFICATION A3. *Upper Zodiac:* (year –447, 16-18 May, average deviation equals 14 degrees). *Lower Zodiac:* no solutions.

IDENTIFICATION A4. *Upper Zodiac:* (year –327, 11 April, average deviation equals 19 degrees); (year 1262, 20-22 May, average deviation equals 16 degrees). *Lower Zodiac:* no solutions.

IDENTIFICATION A5. *Upper Zodiac:* (year 1230, 15-16 May, average deviation equals 7 degrees). *Lower Zodiac:* (year 237, 7-8 February, average deviation equals 14 degrees).

IDENTIFICATION A6. *Upper Zodiac:* (year 79, 21-22 May, average deviation equals 15 degrees); (year 256, 12 May, average deviation equals 19 degrees); (year 1847, 2-3 June, average deviation equals 15 degrees). *Lower Zodiac:* (year –452, 10-11 January, average deviation equals 9 degrees); (year 225, 21-23 January, average deviation equals 8 degrees).

Table 18.2 demonstrates that there is just a single version of identifying the fantasy birds from the zodiacs of Athribis with planets; the pair of resulting solutions is separated by an interval of a suitable length. The solutions are as follows: 12 May 256 A.D. for the Upper Zodiac and 21-23 January 225 A.D. for the Lower. There are no other solutions with an acceptable difference between the dates of the upper and the lower zodiac in table 18.2. The next pair is separated by an interval of 150 years (79 and 225 for the same identification A6); the next interval is already one of 600 years.

It turns out that the pair of dates in question doesn't represent the exhaustive solution of the Athribis zodiacs. The matter is that the solution of 225 A.D. for the lower zodiac doesn't suit us insofar as the secondary horoscope of summer solstice is concerned (which we encountered on the zodiac and analysed

A1		*A2*		*A3*		*A4*		*A5*		*A6*	
Upper AV AV1	*Lower AV AV1*	*Upper AV AV2*	*Lower AV AV2*	*Upper AV AV3*	*Lower AV AV3*	*Upper AV AV4*	*Lower AV AV4*	*Upper AV AV5*	*Lower AV AV5*	*Upper AV AV6*	*Lower AV AV6*
–244	no solutions			–447	no solutions	–327	no solutions				–452
										79	
									237		225
										256	
		408									
			1125								
								1230			
						1262					
										1847	
1962											

Table 18.2. Astronomical solutions for the Upper (AV) and Lower (AN) Zodiac of Athribis for all six interpretation versions of the primary horoscope (A1 … A6). Only the solution years are given.

above). Don't forget that according to the horoscope, all five planets were in conjunction in Gemini that year (which also housed the Sun during summer solstice) – Mercury, Venus, Jupiter, Saturn and Mars.

We have two possible versions for the summer solstice that corresponds to the solution of 21-23 January 225; one of them is valid if the author of the Zodiac counted the year off the autumn equinox point or the winter solstice point, in September or January, that is. In this case, the January solution of 225 would precede the summer solstice day of the same year; we would then have to take June 225 as the date of the summer solstice. However, if the year began from the vernal equinox or the winter solstice according to the author of the zodiacs (in March or June, that is), our January solution shall postdate the summer solstice point of the same year. We shall then have to consider the preceding June of 224 A.D. However, since we don't know the author's opinion, we shall consider both versions (none of them will turn out valid, as a matter of fact).

If the year begins in September or January, that is, if the summer solstice day fell on 225 (20 June, qv in Annex 5), there were only four planets in Gemini and the neighbouring constellations of Leo, Cancer, Taurus and Aries, excluding the Sun and the Moon. Namely, Jupiter and Mars were in Leo, the Sun and Mercury in Gemini, and Venus in Taurus, from the side of the Gemini. The fifth planet (Saturn) was in Capricorn that day, on the opposite side of the ecliptic; we cannot ascribe it to the horoscope of summer solstice in this case. As a result, we come up with an astronomical situation that corresponds with this secondary zodiac, since we find all five planets in it, with the exception of the Sun. The Moon is of no assistance to us, since its symbolism (either a crescent or a circle) is absent from the secondary horoscope.

The beginning of the year in March or June also doesn't save the solution of 225 A.D. Indeed, in the March (or June) year that corresponds to this solution the summer solstice day fell on 20 June 224 A.D. – however, Saturn remained in Capricorn that day. In other words, the secondary horoscope of summer solstice presents conditions that cannot be satisfied yet again.

We must concede to having found no exhaustive solutions for the zodiacs of Athribis. However, we must point out that the abovementioned calculation involves exceptionally high criteria for the astronomical solutions of the Athribis zodiacs.

The matter is that we find planetary agglomerations next to the Sun in both of the zodiacs; this is especially manifest in the Lower Zodiac, where we see three planets (minus the Sun) next to each other, surrounding the luminary while being right next to each other. However, the agglomeration of planets around the Sun implies that some of them may have been invisible that day, which is the fate of every planet that approaches the Sun too closely. It is obvious that the respective order of the planets couldn't have been observed in the celestial sphere immediately. One could figure out the respective order of some planets knowing the average comparison rate of their speed; however, the order of invisible planets in relation to the Sun would have to be calculated. This was anything but an easy task in the olden times, when every arithmetical operation would take a great toll on time and effort.

Therefore, if the horoscopes in the Athribis zodiacs were compiled from actual observations and not accurate astronomical calculations, the order of the planets in relation to the Sun contained therein might be erroneous. We have to account for this possibility, since this minor detail might well be standing between us and the exhaustive solution of the Athribis zodiacs.

1.4. Calculation results for six versions with random order of invisible planets

We have performed extensive astronomical calculations for the zodiacs of Athribis, accounting for possible discrepancies in the order of the *invisible* planets. In the new calculations we allowed for a random order of invisible planets. The respective source data for the Horos program are given in Annex 4 (see data codes ANA, ANB, ANC, AND and ANF for the Lower Zodiac; the ones for the Upper Zodiac of Athribis are AVA, AVB, AVC, AVD and AVF).

Since the Horos program cannot estimate planetary visibility, our research was done in several stages.

In the first stage the Horos program would search for all possible astronomical solutions, allowing for random order changes of the planets within the

group of three, including the Sun, in the Upper Zodiac of Athribis, and a similar group of four with the Sun included in the Lower. As above, solutions were searched on the interval between 500 B.C. and the present day.

Then, in the second stage, we would study each of the solutions found in order to make certain that the difference between the solution in question and the specifications of the respective zodiac only concerns the *order of the invisible planets in relation to each other.* Visibility estimates were rough, based on the longitudinal declination of the planets exclusively. A planet would be considered visible if its solar declination equalled 12 degrees of longitude minimum. Our objective had been to get rid of all the cases where the planetary order in the solution would be broken for a priori visible planets.

In the third stage we would estimate all the possible pairs of close dates for both of the Athribis zodiacs. We would only allow for solutions where the dating for the Upper Zodiac would be at the maximal distance of 150 years from the estimated dating of the Lower Zodiac. The visibility of planets found near the Sun would be calculated more accurately, with the aid of the Turbo-Sky software. We assumed that the observation point was located somewhere in Egypt – in either Cairo or Luxor. Considering observation points located further to the North was hardly a necessity, since the angle between the ecliptic and the local horizon is smaller in the northern latitudes, and that makes visibility conditions for the planets in solar vicinity even worse.

The end result of the first two stages of calculation is presented as Table 18.3. It is compiled in the same way as the table 18.2 above.

Let us cite the exact dates for all the solutions from the table. By "average deviation" we shall understand the "average deviation from best points". Bear in mind that it might differ from the one we came up with for the same solution in Table 18.2, since the best points were altered to some extent in order to allow for a different planetary order. See printouts of source data in Annex 4.

IDENTIFICATION A1. *Upper Zodiac:* (year -244, 21-

A1		*A2*		*A3*		*A4*		*A5*		*A6*	
Upper AV AVA	*Lower AV AVA*	*Upper AV AVB*	*Lower AV AVB*	*Upper AV AVC*	*Lower AV AVC*	*Upper AV AVD*	*Lower AV AVD*	*Upper AV AVE*	*Lower AV AVE*	*Upper AV AVF*	*Lower AV AVF*
–244	no solutions			–447	no solutions	–327	no solutions				–452
										79	
									237		225
										256	
		408									
			444							459	
			1125					1230			
1227						1262			1268		
										1847	
1962											

Table 18.3. Astronomical solutions for the Upper and Lower Zodiac of Athribis (AV and AN, respectively) for all six interpretation options of the primary horoscope *and a random order of invisible planets*. We only specify the years of solutions.

23 May, average deviation equals 15 degrees); (year 1227, 20 April, average deviation equals 17 degrees); (year 1962, 21-22 May, average deviation equals 13 degrees). *Lower Zodiac:* no solutions.

Identification A2. *Upper Zodiac:* (year 408, 13 May, average deviation equals 19 degrees). *Lower Zodiac:* (year 448, 18-20 January, average deviation equals 10 degrees); (1125, 30 January – 2 February, average deviation equals 10 degrees).

Identification A3. *Upper Zodiac:* (year –447, 16-18 May, average deviation equals 14 degrees). *Lower Zodiac:* no solutions.

Identification A4. *Upper Zodiac:* (year –327, 11 April, average deviation equals 19 degrees); (1262, 20-22 May, average deviation equals 16 degrees). *Lower Zodiac:* no solutions.

Identification A5. *Upper Zodiac:* (year 1230, 15-16 May, average deviation equals 7 degrees). *Lower Zodiac:* (year 237, 7-8 February, average deviation equals 13 degrees); (1268, 8-11 February, average deviation equals 6 degrees for 9-10 February).

Identification A6. *Upper Zodiac:* (year 79, 21-22 May, average deviation equals 15 degrees); (year 256, 12 May, average deviation equals 19 degrees); (year 459, 18 May, average deviation equals 12 degrees); (year 1847, 2-3 June, average deviation equals 15 degrees). *Lower Zodiac:* (year –452, 10-12 January or 3-8 February, average deviation equals 10 degrees); (year 225, 20-24 January, average deviation equals 9 degrees).

As one can see from the table, there are just three pairs of dates situated close enough to one another, which leaves us with a total of three possible solutions for the zodiacs of Athribis:

1) 408 and 448 A.D. (average deviations from best points equalling 19 degrees and 10 degrees, respectively);

2) 1230 and 1268 A.D. (average deviations equalling 7 degrees and 6 degrees);

3) 256 and 225 A.D. (average deviations equalling 19 degrees and 9 degrees).

However, the third solution (256 and 225 A.D.) already surfaced in our primary calculations, qv in Chron3, Chapter 18:1. It was rejected due to its failure to correspond with the secondary horoscope of summer solstice in the lower zodiac. Let us point out that the date we had to reject relates to the lower zodiac exclusively (225 A.D.) – it simply makes no sense to try a new date with it (namely, 79 A.D.), which isn't that far away on the time scale; the matter is that the Lower Zodiac date shall remain the same – namely, 225 A.D., and we have already rejected it.

We are thus left with two possible solutions, the first pair being 408 and 448 A.D., and the second – 1230 and 1268 A.D. As we shall see below, the first one will have to be rejected, whereas the second proves ideal (jumping ahead, we shall tell the reader that it turned out to be our final and exhaustive solution for the zodiacs of Athribis). We shall study it meticulously in the next couple of sections, and also demonstrate the non-existence of other exhaustive solutions, even if one were to allow for a much wider scope of interpretations, in Annex 6, with the aid of extensive additional calculations.

Let us first consider the solution of 408 A.D. for the Upper and 448 A.D. for the Lower Zodiac. Planetary positions on the days in question were as follows:

Julian day (JD) = 1870213.00 <The Upper Zodiac of Athribis>
Year/month/date = 408/5/13

Sun	Moon	Saturn planet 4	Jupiter planet 1	Mars planet 3	Venus planet 2	Mercury
75.1	96.6	38.6	338.4	298.6	98.3	91.2
Taurus	Gemini	Aries	Aquar.	Sag/Cap	Gem	Gem/Tau

Average deviation from "best points": 19 degrees.
Identification A2, data code AV2 or AVB (see Annex 4).

Julian day (JD) = 1884708.00 <The Lower Zodiac of Athribis>
Year/month/date = 448/1/19

Sun	Moon	Saturn planet 4	Jupiter planet 1	Mars planet 3	Venus planet 2	Mercury
322.1	286.0	175.0	91.6	315.7	319.1	336.9
Capric.	Sagitt.	Leo/Vir	Gem.	Capric.	Capric.	Aquarius

Average deviation from "best points": 10 degrees.
Identification A2, data code ANB (see Annex 4).

We must instantly point out that the above planetary positions don't quite satisfy to the specifications of the Upper Zodiac. Indeed, planet #4 (or Saturn in this identification) is drawn immediately underneath

Taurus in the Upper Zodiac of Athribis; there is some empty space left under Aries, and so the author of the zodiacs could have easily drawn the planet under Aries, had he wanted to. He had done nothing of the kind, as we can see, since he drew it under Taurus, right next to the two other planetary figures (the Sun and Mercury). Therefore, the position of Saturn for 13 May 408 A.D. can be presumed to coincide with the middle of Aries, at 12 degrees from the border with Taurus, and at a whole 36 degrees from the Sun, is in very approximate correspondence with the drawing on the Upper Zodiac.

Furthermore, the "meeting scene in Leo" as described above receives no astronomical explanation in 408. In the summer of 408 Venus was passing through the constellation of Leo alone; Mercury had turned back towards the Sun in Gemini/Cancer. Mars was between Capricorn and Aquarius – on the other side of the ecliptic, that is. Jupiter was in Aquarius, and Saturn in Aries; in other words, all of the above-mentioned planets were far enough from Leo (calculated in Turbo-Sky).

Thus, Mercury wasn't in conjunction with any "male" planet in Leo that year, and so the scene in question becomes suspended. It is easy enough to come up with mystical explanations, as previous researchers were very prone to doing. However, we already know that no "extraneous" scenes void of astronomical meaning were ever drawn in any Egyptian zodiac; the zodiacal symbolism reflected actual astronomical phenomena quite meticulously, and so an exhaustive solution should present us with the opportunity of giving an astronomical explanation to every symbol present in the zodiac under study. We don't find this to be the case here.

Now let us see how well the conditions specified in the Lower Zodiac are satisfied in the solution under consideration. The date we came up with in this case is 18-20 January 448 A.D.; it wasn't present in the previous calculation, which means that the order of some invisible planets for that date didn't coincide with their order in the zodiac. The planetary longitudes for 19 January 448 as cited above demonstrate that Venus was indeed located on the other side of the Sun on that date as compared to how the two are drawn in the zodiac. Nevertheless, its longitudinal declination from the Sun equalled a mere 3 degrees, which would render the planet perfectly invisible, making it impossible for the telluric observer to determine the exact respective order of Venus and the Sun on the ecliptic. We have no right to reject the dating on these grounds. As for the distribution of planets across the constellations, it corresponds with the zodiac well enough.

As we already pointed out above, the secondary horoscope of summer solstice for the dating of 18-20 January 448 can have two options, the first one being the summer solstice of 448, which corresponds to the September or January beginning of the year. The other one is the summer solstice of 447, if the beginning of the years referred to in the zodiacs of Athribis fell on March or June. Let us point out that in every case studied above we saw Egyptian zodiacs specify a September year, which was apparently linked to the point of autumn equinox. However, this doesn't preclude us from coming across an Egyptian zodiac that will use a different system for the beginning of a year – one linked to the spring equinox point in March, for instance, or the summer solstice point in June. We shall therefore keep checking all possible options.

A Turbo-Sky calculation demonstrates that all five planets were in conjunction with the Sun in June of 447, likewise June 448, on the day of summer solstice (in Gemini), forming a configuration that resembles what we see in the respective secondary horoscope of the Lower Zodiac. However, the correspondence with the zodiac wasn't ideal in 448; nevertheless, it had been such in 447, which would imply a March or June beginning of a year.

Let us begin with the summer solstice of 448. On 19 June 448, on the day of summer solstice, the planetary disposition on the ecliptic had been as follows: Saturn and Venus in Leo; Jupiter, the Sun and Mercury in Gemini, and, finally, Mars in Taurus. Therefore, Venus ends up in the triad "underneath the feet of the Sun", on the side of vespertine visibility. The secondary horoscope specifies it as one of the two planets one sees over the head of the Sun. The correspondence remains, but it is incomplete.

On 19 June 447, which was the preceding day of summer solstice, the planetary disposition corresponded to the secondary horoscope ideally. The planetary order was as follows (calculated in Turbo-

Sky): Mars, Saturn and Mercury in Leo/Cancer (vespertine visibility, or "underneath the feet of the Sun". The Sun was in Gemini. Jupiter and Venus were in Taurus, on the side of matutinal visibility, or "above the head of the Sun". Venus was further away from the Sun than Jupiter. This is just what we see in the secondary horoscope of summer solstice in the Lower Zodiac.

Let us sum up.

In the pair of dates under study (13 May 408 A.D. for the Upper Zodiac and 18-20 January 448 A.D. for the Lower), only the second satisfies to all the conditions set by the exhaustive solution. The first date corresponds to the Upper Zodiac very poorly insofar as the position of Saturn is concerned; moreover, it cannot explain "the scene of meeting in Leo" as found in the Upper Zodiac. Therefore, the solution of 408 and 448 cannot be the exhaustive solution for the zodiacs of Athribis – it could only be of use as a stopgap solution had we found no ideal one. However, there is in fact an ideal solution for this pair of zodiacs.

1.5. The exhaustive solution of the zodiacs from Athribis: 15-16 May 1230 for the Lower, and 9-10 February 1268 for the Upper Zodiac

The second solution that we came up with for the zodiacs of Athribis proved to be complete and exhaustive, rigidly corresponding to both the distribution of planets across constellations and the planetary order specified in the zodiacs, and also all of the additional information that the zodiacs contain, with no exceptions, namely:

15-16 May 1230 A.D. for the Upper Zodiac, with the average deviation from best points equalling a mere 7 degrees;

9-10 February 1268 A.D. for the Lower Zodiac, the average deviation from best points equalling just 6 degrees. It has to be noted that such small values of average deviation rate are very rare, and indicate exclusively high correspondence between the planetary positions in the solution and the zodiac.

Let us specify precise positions of planets on the ecliptic for the days in question. The first row of values contains planetary longitudes for the ecliptic J2000, as usual, with the positions of planets on the "constellation scale", qv in CHRON3, Chapter 16:10, specified underneath, and the constellation housing the planet below.

THE SOLUTION OF THE ATHRIBIS ZODIACS. PRIMARY HOROSCOPE, IDENTIFICATION A5. DATA CODES: *AVE* FOR THE UPPER ZODIAC AND *ANE* FOR THE LOWER (SEE ANNEX 4)

Julian day (JD) = 2170451.00 <The Upper Zodiac of Athribis>
Year/month/date = 1230/5/16

Sun	Moon	Saturn planet 1	Jupiter planet 4	Mars planet 3	Venus planet 2	Mercury
72.6	104.9	4.4	81.0	329.6	116.3	87.8
1.55	2.53	11.45	1.77	10.01	2.92	1.95
Taurus	Gemini	Pisces	Taurus	Cap/Sag	Gem/Can	Tau/Gem

Average deviation from "best points": 7 degrees.

Julian day (JD) = 2184234.00 <The Lower Zodiac of Athribis>
Year/month/date = 1268/2/9

Sun	Moon	Saturn planet 1	Jupiter planet 4	Mars planet 3	Venus planet 2	Mercury
337.9	278.9	104.2	144.3	322.9	328.2	339.0
10.49	8.35	2.50	4.02	9.76	9.95	10.55
Aquar.	Sagitt.	Gem.	Leo/Vir	Capric.	Cap/Aqua (invisible)	Aquar. (invisible)

Average deviation from "best points": 5.5 degrees.

We have used the Turbo-Sky software in order to estimate which planets were visible in the solutions we came up with, and which were invisible a priori.

Visibility conditions for the Upper Zodiac. All the planets here were visible very well, except for Jupiter. Jupiter set in Cairo on 16 May 1230 with the solar submersion rate equalling 7 degrees; the luminosity of the planet had equalled –1.4.

These conditions must have made Jupiter invisible, with the possible exception of a few brief moments, at the very horizon. The nearby Mercury was already visible quite well, since the solar submersion rate had equalled 14 degrees when it rose. The new Moon just appeared in Gemini, looking like a narrow crescent; it had been two days of age.

Visibility conditions for the Lower Zodiac. Proximity to the Sun rendered Mercury and Venus invisible; the former was at the distance of one or two degrees from the Sun, and its visibility is quite out of the question. Venus was located on the side of matutinal visibility in relation to the Sun. It was also invisible, since it rose in Cairo on 9-10 February 1268 at the solar submersion rate of just 5 degrees, which is insufficient even for planet this bright (its luminosity had equalled –3.4 that day). Other planets were visible well enough. Mars had been the closest to the Sun; it rose at the solar submersion rate of 9 degrees, which would make the planet (whose luminosity had equalled +1.4) visible before dawn, albeit for a short time.

1.6. A comparison of planetary positions in the solutions with those specified in the zodiacs

Let us now compare the positions of planets in the solution that we discovered to the ones indicated in the zodiacs of Athribis. We must adhere to identification option A5 for Jupiter, Saturn and Mars, since this is the identification that gave us the solution under study. See above (CHRON3, Chapter 18:1.1) for the interpretation of all identifications. Thus, the positions of planets in the zodiacs and in our solutions were as follows.

PLANETARY POSITIONS FOR THE UPPER ZODIAC (identification option A5):

The Sun in Taurus.

Jupiter in Taurus, underneath the Sun and right next to it.

Mercury in Taurus, on the side of Gemini, right next to Jupiter.

Mars in Capricorn.

Saturn in Pisces.

Venus at the cusp of Gemini and Cancer.

The Moon in Gemini, close to Venus.

PLANETARY POSITIONS IN THE SOLUTION OF 15-16 MAY 1230 FOR THE UPPER ZODIAC:

The Sun in Taurus. The nearest planet to the Sun is Jupiter.

Jupiter in Taurus, right next to the Sun. Could only be visible at the very horizon right before sunrise.

Mercury in Taurus, near the border with Gemini.

Mars at the cusp of Capricorn and Aquarius.

Saturn in Pisces.

Venus at the cusp of Gemini and Cancer.

The Moon in Gemini, near Venus, two days of age. The crescent of the new moon appeared in the sky for the first time that day.

PLANETARY POSITIONS IN THE LOWER ZODIAC (identification option A5):

The Sun between Capricorn and Aquarius.

Venus in Aquarius or in Pisces, right next to Mercury and the Sun.

Mercury in either Pisces or Aquarius, right text to Venus.

Mars in Capricorn, touching the Sun with its serpent tail.

Saturn in Gemini.

Jupiter in Leo.

Moon in Sagittarius.

PLANETARY POSITIONS IN THE SOLUTION OF 9-10 FEBRUARY 1268 FOR THE LOWER ZODIAC:

The Sun in Aquarius.

Venus in Aquarius, near the border with Capricorn.

Mercury in the middle of Aquarius, close to Pisces (Aquarius occupies a mere 17 degrees on the ecliptic).

Mars in Capricorn, on the side of Aquarius – close to the Sun, yet visible.

Saturn is in Gemini.

Jupiter is at the cusp of Leo and Virgo.

Moon in Sagittarius as a 25-day-old crescent.

A comparison of planetary positions for the two zodiacs leads us to the following conclusion:

The concurrence is ideal for the Upper Zodiac. It is also ideal for the Lower Zodiac, given that Venus was invisible. It had been obscured by the Sun, which made it impossible for the compiler of the horoscope to see what side of the Sun it was on. This task would require some additional labour, which we cannot quite expect from the author of the zodiac. In other words, if we are to assume that the zodiacs of Athribis were compiled from accrual observations, without any additional astronomical calculations, both dates need to be recognized as ideal from the viewpoint of planetary disposition in both zodiacs – we see excellent concurrence for every planet in both zodiacs with no exceptions.

The only thing that we need to verify is the correspondence of the solution to the secondary horo-

scope of summer solstice in the Lower Zodiac, and the "scene of meeting in Leo" in the Upper.

The additional scene with the Passover moon located at the very bottom of the zodiacs from Athribis (it is highlighted green in the "coloured" version of the Lower Zodiac) was analysed meticulously in CHRON3, Chapter 15:9.1. The scene itself is very interesting, but cannot help us with the choice of solutions.

1.7. Checking correspondence to the secondary horoscope of summer solstice

Let us cite the positions of planets on the ecliptic for both the summer solstice day of 12 June 1268 A.D. and the summer solstice day of 12 June 1267 A.D. In the first case we assume that the Athribis zodiacs employ a September or January year, and in the second case – a year beginning in March or June.

As above, the first line indicates the longitude of a planet on the J2000 ecliptic, whereas the second specifies the planetary position of the "constellation scale" (qv in CHRON3, Chapter 16:10) and the third one corresponds to the name of the constellation where the planet was located. All the planets are arranged by longitude for the sake of convenience.

SEPTEMBER OR JANUARY BEGINNING OF YEAR

Julian day (JD) = 2184358.00 <Summer solstice of 1268 A.D.>
Year/month/date = 1268/6/12

Mars	Sun	Moon	Saturn	Mercury	Venus	Jupiter
57.1	98.6	101.6	112.4	117.4	121.0	148.1
1.15	2.31	2.41	2.79	2.96	3.10	4.15
Taurus	Gemini	Gemini	Gemini	Gemini	Cancer	Leo

The figures are telling us that we do indeed see a correspondence with the secondary zodiac, and a good one at that. All the planets congregated around the Sun in Gemini, just as they had to. Nevertheless, we cannot say the concurrence is ideal. The disposition of planets in relation to the Sun differs from what we see specified in the secondary horoscope, where we see three planets to one side of the Sun, and two more to the other. However, on the summer solstice of 1268 there were four planets that had congregated on the same side of the Sun, apart from the Moon. There was just a single planet on the other side of the Sun – namely, Mars. It is therefore obvious that we can find no ideal correspondence with secondary horoscopes here.

Now let us try the other version, with the year beginning in March or in June. In this version, the summer solstice falls over 12 June 1267 on the year of our solution, give or take a day. Let us explain that this date falls over a different year than the 8-11 February 1268 specified in the Lower Zodiac due to the fact that nowadays we begin the year from January, and not June or March.

Let us cite the planetary positions on the ecliptic for 10 June 1267, two days before solstice, when the correspondence with the secondary zodiac is simply spectacular. However, it was virtually ideal on 12 June 1267 as well, since planetary positions couldn't alter all that greatly over two days. The only difference is that Mercury, having been right next to the Sun, resurfaced on its other side. Still, Mercury had been so close to the Sun on each of the days under consideration that it couldn't possibly be seen under any circumstances; the author of the Athribis zodiacs could therefore do nothing but guess what side of the Sun to draw the planet on. We must also bear in mind, that it had taken the mediaeval astronomers quite a while to learn the art of estimating solstice and equinox days with precision – even in XIV century books one encounters 5-6-day errors in their estimation, qv in CHRON6, Chapter 19. The position of planets for 10 June 1267 on the days of summer solstice was therefore as follows:

JUNE OR MARCH BEGINNING OF YEAR

Julian day (JD) = 2183990.00 <Summer solstice of 1267 A.D.>
Year/month/date = 1268/6/10

Venus	Mercury	Sun	Saturn	Jupiter	Mars	Moon
76.5	95.0	96.0	99.7	122.6	151.6	301.3
1.66	2.19	2.22	2.35	3.16	4.26	8.99
Taurus	Gemini	Gemini	Gemini	Cancer	Leo	Capric.

The correspondence with the secondary horoscope from the zodiacs of Athribis is ideal, with all of the minute details coinciding.

Indeed, on 10 June 1267 all five planets (Mercury, Venus, Jupiter, Saturn and Mars) congregated near the Sun, as it is drawn in the secondary horoscope. Furthermore, two planets out of five (Venus and Mars) turned out to be "over the head of the Sun", just as it is specified in the Egyptian drawings, likewise the three other planets on the side of vespertine visibility (under the feet of the Sun). Venus is one of the planets "near the head of the Sun", which is what we see in the drawing.

Another parallel with the Egyptian drawing is the fact that Venus had been further away from the Sun than the second planet next to it. One also has to point out that the Moon, which we find absent from the present secondary horoscope, had been very far away from the Sun, and couldn't have been drawn in the horoscope by definition. On the days of summer solstice in 1267 the Moon had almost been at the opposite end of the ecliptic from the Sun. On the other hand, all the remaining planets had been close to the Sun and entered the secondary horoscope. Mercury and Saturn were in Gemini, right next to the Sun, and Venus in Taurus, closer to Gemini. Jupiter was in Cancer, near the border with Gemini. Mars was at the beginning of Leo, somewhat further away from the Sun than the four other planets – its solar declination rate equalled circa fifty degrees; Mars was at the border between the two respective secondary horoscope areas of summer solstice and autumn equinox. In this situation, the inclusion of Mars into the secondary horoscope of summer solstice is perfectly legitimate and even necessary from the viewpoint of ancient Egyptian astronomical symbolism.

As a result, the correspondence with the secondary horoscope proves exceptionally precise. We found no flaws here whatsoever.

Finally, one cannot fail to mention that the abovementioned Egyptian names as discovered and read by Brugsch came from this particular area of the zodiac that is usually reserved for the summer solstice horoscope; according to our solution, these names refer to Venus and Mercury. We see a remote similarity between the Egyptian names and the modern ones. Indeed:

Meri-Hor = *Mer-Gor* = *Mer-Cur* (Mercury), or *Mer*(cury)-*Horus*.

Ab-Ne-Mani = *BN-Mani* = *VN-Mani* = *VeNus-Mani*.

Bear in mind that Egyptian names were spelt as consonants only, and their vocalizations are random in most cases. Apart from that, the sounds B and V were often subject to flexion, especially in names – it suffices to recollect name pairs such as Barbara vs Varvara, Benedict vs Venedikt etc. Therefore, the consonants BN in the name Ab-Ne-Mani might well stand for Venus – VEN being the root, and "us" – a standard Latin suffix. It is therefore possible that Venus was simply referred to as VN or BN in Egyptian zodiacs, which is what we see in the present case.

However, even regardless of how the Egyptian names become interpreted, we can state with perfect certainty that we see perfect correspondence between our solution and the zodiacs of Athribis in the area of the summer solstice horoscope. Even the minor details coincide. Apart from that, we have discovered a very noteworthy phenomenon – apparently, the beginning of the year as implied in the zodiacs from Athribis isn't counted from September, as we find it to be the case with other Egyptian zodiacs that we studied, but rather June or March; in the next section we shall decide which of the two marked the New Year in the zodiacs under study.

1.8. Verification by the "scene of meeting in Leo"

Let us now check the dating we got for the Upper Zodiac for correspondence to the additional "scene of meeting in Leo". This scene is present in the perimeter scene, to the left from the Upper Zodiac; we have studied it in detail above, in CHRON3, Chapter 18:1.8. The symbolic scene represents the meeting of a two-faced man (most probably, Mercury) and another male figure, which must stand for another "male planet". It can be Saturn, Jupiter or Mars. Both figures are standing on the back of a lion holding hands; the lion (lioness?) has got a human (possibly female) face. Bear in mind that a lioness – especially one with a female head, stood for Venus in Leo according to the general laws of Egyptian astronomical symbolism. We came across this symbol in a variety of different zodiacs from Egypt.

Let us consider the situation in Leo when Venus and Mercury were passing through the constellation on the year of our solution. These planets are never

too far away from the Sun, and so we know the approximate time of this event – namely, the period between July and September when the Sun travels through the constellations of Gemini, Cancer, Leo and Virgo.

We are once again forced to consider two options at once that correspond to different traditions of beginning a year. Since the date of the Upper Zodiac fell on May in our solution (13 May 1230), we shall have to search for whatever phenomena the scene stands for in July-September 1230, whereas in case of a summer year, or one that would begin around the time of summer solstice, the previous year will have to be considered (1229). In that case, the May dating for the Upper Zodiac from 1230 shall wind up in the June year that began in June 1229 and ended in June 1230.

It will also be extremely interesting to find out what tradition of beginning a year the authors of the zodiacs from Athribis adhered to. We already discovered that the years reflected in these Zodiacs had an unusual beginning, which fell over June or March. On the other hand, the zodiacs from Athribis also stand alone due to containing no other secondary horoscopes except for the horoscope of summer solstice. The three other constellations that house the solstice and equinox points (Virgo, Pisces and Sagittarius) aren't singled out in any way at all. One should mark that the symbols of these points are still present in the perimeter strip of figures found in the Athribis zodiacs, but summer solstice obviously enjoys very special attention. The symbols of all other equinoxes and solstices are separated from corresponding constellations and simply placed in the perimeter strip. Once again, let us emphasise that none of the above is typical for Egyptian zodiacs.

And so, let us commence with searching the "scene of meeting in Leo" in 1229 or 1230. Our astronomical calculations, as well as verification in Turbo-Sky, demonstrate that in July-September 1230, when Venus and Mercury were passing through Leo, the three other planets (Mars, Saturn and Jupiter) were at a considerable distance from the pair, Mars being in Aquarius, Saturn in Pisces, near the border with Aquarius, and Jupiter in Gemini. There could therefore be no "meeting" between Mercury and any male planet in Leo that year. In general, we failed to find any other astronomical situation that would relate to this rather vivid Egyptian scene in 1230.

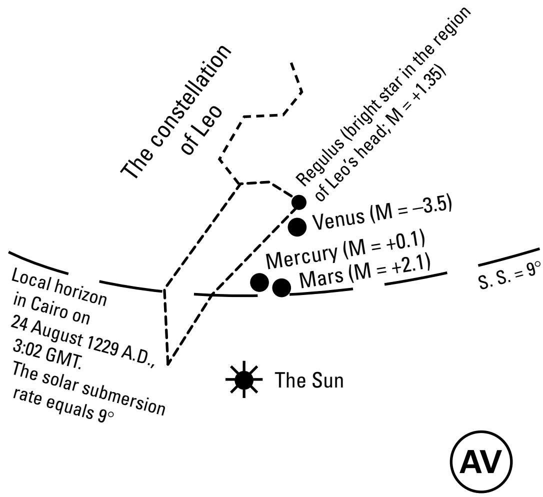


Fig. 18.3a. Mercury meeting Mars in the sky above Cairo before the dawn of 24 August 1229, the same June year that contains the date of the Upper Zodiac from Athribis. We see the moment that Mars rose at 3:02 AM GMT, when the solar submersion rate had equalled 9 degrees. It was still rather dark, in other words. One could see Mars and Mercury near the horizon and Venus somewhat further above, next to Regulus. The correspondence with the "scene of meeting in Leo" from the Upper Zodiac of Athribis is ideal. The drawing is approximated (calculated in Turbo-Sky).

However, we instantly find a correspondence in 1229, and an ideal one at that – namely, on 24 August 1229, the constellation of Leo rose before sunrise in Cairo; it had housed three planets – Mercury, Mars and Venus. In full accordance with the scene, Mercury and Mars are very close to each other (the distance between the two only equalled one degree). Venus was at the distance of two degrees from Regulus (the Alpha of Leo) – the brightest star in this part of the sky, located approximately near the head of Leo.

All the abovementioned planets, likewise Regulus, were visible well before sunrise in Cairo, at 3 AM GMT, at the solar submersion rate of 9 degrees. Mercury and Mars rose simultaneously at this point; Venus and Regulus had already risen over the horizon noticeably, qv in fig. 18.3a. The luminosity of Mercury had equalled +0.1, and that of Mars, +2.1, which made them resemble bright stars. Therefore, Mars and Mer-

cury were visible perfectly well before dawn in Cairo, let alone Venus and Regulus. Don't forget that the brightest stars become visible when the solar submersion rate equals 7-8 degrees, qv in CHRON3, Chapter 16:7.3. However, dim stars disappear from sight at the solar submersion rate of 9 degrees already.

As a result, the celestial sphere in Cairo looked as follows before dawn: Mercury and Mars were right next to each other over the very horizon. A little above them one could see another pair of exceptionally bright stars – Venus and Regulus. All the other stars in this area of the sky had grown dim.

This is in perfect correspondence with the symbolic Egyptian scene with Mercury meeting another male planet. They meet on the back of a lion – in the constellation of Leo, that is. The proximity of planets to one another is emphasized by the fact that we see them hold hands. The lion they are standing on has a female head, which is a very explicit reference to Venus next to Regulus.

And so, all the astronomical conditions specified by the zodiacs of Athribis are satisfied to ideally in the solution of 1230 and 1268 that we discovered, which makes this solution exhaustive. Below we shall demonstrate there to be no other exhaustive solution for the zodiacs of Athribis, even in case of significant variations in their interpretation. The exhaustive solution in question therefore appears to be the only one possible.

1.9. The archaic June year as used in the zodiacs of Athribis

The corollary that we come to here is that the year would begin with summer solstice in the Athribis zodiacs, or in June according to the Julian calendar. Indeed, our verification of the secondary horoscope of summer solstice demonstrated that a year should begin in spring or in the summer – there can be no ideal correspondence between the solution and the secondary horoscope otherwise. On the other hand, after the verification of the "scene of meeting in Leo" we learnt that the year began with the summer solstice, according to the opinion of the zodiacs' author – in June, that is. All of the above is telling us that the beginning of a year really fell upon June – we simply have no other option.

It becomes clear why the summer solstice horoscope is emphasised in the Athribis zodiac, with no other secondary horoscopes present. If summer solstice marked the beginning of a year, the special attention that it gets is perfectly understandable – otherwise it would seem rather odd.

Nevertheless, in every other Egyptian zodiac that we studied the beginning of a year always fell on September and was tied to the point of autumn equinox. This may be an indication that the Athribis zodiacs are the oldest Egyptian zodiacs known to us, and so they represent the archaic tradition of beginning the astronomical year in the summer, making the summer solstice mark the beginning of a new year.

This assumption is also confirmed by the dating of the Athribis zodiacs. The solution that we came up with dates them to the second half of the XIII century; they must have undergone no alterations ever since, remembering as how the funereal cave with the zodiac had remained completely buried in the sand for a long time. They were discovered during excavations, when the sand was removed, by the famous English archaeologist Flinders Petrie at the very beginning of the XX century, qv above.

It is therefore most likely that all the other zodiacs that we had to study date to a much more recent epoch than the ones from Athribis, although the dates transcribed in them could be more ancient in some cases – the Dendera zodiacs, for instant, contain dates from the XII century A.D.

Let us also point out that the zodiacs of Athribis contain direct indications that they were compiled from actual celestial observation, with no additional astronomical calculations involved, which is yet another characteristic that makes them differ from other Egyptian zodiacs. The matter is that these zodiacs prove extremely precise about everything that concerns the visible part of the celestial sphere; however, once the invisible part comes into play (or the immediate solar vicinity), they instantly begin to yield minor errors and discrepancies.

We don't find anything in the way of such drastic differences between the way the visible and invisible celestial areas are drawn in any other Egyptian zodiac, which indirectly confirms our theory that most of them were either calculated, or at least backed up by additional astronomical calculations. However, we

don't find a single trace of such calculations anywhere in the zodiacs from Athribis, which would be only natural for truly ancient zodiacs.

1.10. Final identification of the planetary birds

Let us now consider the final identifications of planetary birds from the Athribis zodiacs implied in our solution. According to identification option A5, which led us to the exhaustive solution, the three planets that had remained without identification primarily – namely, Jupiter, Saturn and Mars, are represented in the zodiac as follows:

Jupiter is the bird with the head and the tail of a serpent. It is marked as number 2 in fig. 18.3.

Saturn is the bird with the crescent-shaped horns on its head, marked as number 1 in fig. 18.3.

Mars is the bird with folded wings, the tail of a serpent and a large beak of a predator marked as number 3 in fig. 18.3.

What can we say about the resulting identifications? The primary thing is that they do not contradict any planetary symbols that we found in other Egyptian zodiacs. The crescent over the head of a planetary figure is really an attribute of Saturn; this is the case with the zodiacs from Dendera and Esna. Mars looks like a bird of prey, which corresponds well with the "militant" reputation of the planet. Bear in mind that, according to mythology, Mars is the god of war. As for the "serpent-like" appearance of Jupiter, it concurs with the opinion of Flinders Petrie, who was the first to study the zodiacs. He had been of the opinion that the bird with the bodily parts of a serpent is Jupiter, who "casts serpent-like thunderbolts" ([544], Volume 6, page 731). This doesn't confirm the correct identification of Jupiter per se, but somehow indicates it to be quite natural.

Thus, we see that all three planets (Saturn, Jupiter and Mars) became identified just like one should expect, taking into consideration everything that we already know about Egyptian astronomical symbolism. Let us emphasise that we did not choose identifications specifically; they became clear from our exhaustive solution automatically. Therefore, excellent concurrence between the arising identifications and the symbolism of other Egyptian zodiacs serves to confirm the correctness of our approach once again.

1.11. Verification of the solution's stability

We have performed some additional calculations in order to estimate whether the exhaustive solution that we came up with for the Athribis zodiacs can be affected by possible (although unlikely) changes in their interpretation.

Firstly, we have calculated all the options where the solar and lunar symbols can swap places. We often witnessed that the symbols of the Sun and the Moon in Egyptian zodiacs are often easy to confuse for each other. Although the symbols of the Sun and the Moon in the zodiacs of Athribis speak for themselves eloquently enough, we decided to perform these calculations nonetheless, for the sake of security. However, no new pair of solutions was found. We came up with a total of two solutions for the Upper Zodiac, identification option A1 (6-9 June 1108 A.D. and 14-16 June 1962 A.D.), and a single solution for the same Upper Zodiac, identification option A3 (19-22 June 1522 A.D.). There are no solutions for the Lower Zodiac whatsoever. Therefore, the problem of identifying the Sun and the Moon in the zodiacs from Athribis can therefore be considered solved.

Secondly, we have performed calculations applying less rigid criteria to the distribution of planets across constellations – namely, the planets forming groups and located under Taurus in the Upper Zodiac and under Capricorn, Aquarius and Pisces in the Lower Zodiac, were allowed to form random orders, not necessarily in the constellations located above them. The assumption was that whenever a large group of planetary figures becomes congregated in a particular area of a zodiac, their correspondence with constellation figures might be broken due to lack of space. Respective calculations for the Athribis zodiacs are described in detail in Annex 6. However, we came up with no new exhaustive solutions.

Thus, the solution that we discovered for the zodiacs from Athribis is most probably unique.

1.12. Corollaries

The astronomical solution found for the zodiacs from Athribis was successfully verified by both of the primary horoscopes, as well as the entire bulk of additional astronomical information present in the zo-

diacs with no exceptions – namely, the secondary horoscope of summer solstice in the Lower Zodiac and the auxiliary astronomical "meeting scene in Leo" in the Upper. We discovered absolute correspondence between the solution in question and the zodiacs from Athribis, stipulating that the year began with summer solstice in June. It turned out that the one of the zodiacs at least (the Lower) was compiled directly from the results astronomical observations, with no additional astronomical calculations for invisible planets.

The date transcribed in the Upper Zodiac is 15-16 May 1230 A.D.

The date transcribed in the Lower Zodiac is 9-10 February 1268 A.D.

Therefore, the zodiacs from Athribis were created in the second half of the XIII century A.D. the earliest.

The Athribis zodiacs imply that the year began in June, before the day of summer solstice or right on that day. This is where they differ from most of the other Egyptian zodiacs, where the year begins in September and happens to be linked to the autumn equinox point. This might imply that the zodiacs of Athribis were created much earlier than all the other Egyptian zodiacs that we studied.

2. THE THEBAN ZODIAC OF BRUGSCH ("BR")

We already discussed Brugsch's Theban Zodiac in detail above, in CHRON3, Chapter 13:4. In particular, we related the history of how an "extremely ancient" Egyptian wooden coffin was discovered in the XIX century, whose manufacture involved the use of modern joinery techniques. The coffin was presented to Heinrich Brugsch, the famous German Egyptologist of the XIX century. Brugsch discovered an "ancient" Egyptian zodiac on the inside of the coffin lid. A drawn copy of this spectacular zodiac made by Brugsch himself can be seen above, in fig. 12.17.

In the middle of the zodiac we see "the goddess Nuit" wearing an elegant tunic, with zodiacal constellations and other figures drawn to her left and right, as well as a number of demotic subscripts near the constellation figures to the left of Nuit. Brugsch had developed a great interest in the finding, and published the zodiac in his work shortly afterwards ([1054]).

Having read the demotic subscripts, Brugsch discovered that they stand for the names of planets. In other words, there was a horoscope inscribed on the zodiac – one that we refer to as the demotic subscript horoscope from Brugsch's zodiac.

The problem of dating the demotic subscript horoscope was studied by N. A. Morozov ([544], Volume 6). Morozov performed a great body of work in order to date the horoscope astronomically. We must emphasize that there were no interpretation problems involved in this case. The names of all planets were written explicitly next to the figures of the constellations that housed them, qv in fig. 13.14 above.

The result of Morozov's research proved totally flabbergasting. The demotic subscript horoscope only has two precise solutions for the entire historical interval between deep antiquity and the present. They are as follows:

1682 – the first solution obtained by N. A. Morozov for the demotic horoscope;

1861 – the second solution obtained by N. A. Morozov for the demotic horoscope.

Qualitatively, both solutions are virtually equal, qv in CHRON3, Chapter 13:4, where we discuss N. A. Morozov's solutions in detail. The horoscope has no other remotely satisfactory solutions.

N. A. Morozov decided to choose the first solution (1682 A.D.), having considered the second one too recent to be true. Indeed, Brugsch published the zodiac in 1862, which postdates the dating suggested by the solution by just one year (see [1054]).

However, we have discovered two more full horoscopes in the very same zodiac of Brugsch; these aren't subscripts, and form an integral part of the zodiac's artwork. These zodiacs were neither noticed by Brugsch, nor by Morozov. Each of them conceals a certain date. The case we have here is extremely convenient for the purposes of astronomical dating. The same zodiac contains a whole of three full zodiacs – three dates, in other words. It is clear that we are most likely to come up with a reliable dating for a zodiac such as this one, since three dates from a single sarcophagus must all belong to the same epoch.

The two new horoscopes in Brugsch's zodiac became dubbed "the horoscope without rods" and "the

Fig. 18.4. A fragment of Brugsch's zodiac (BR) with the "horoscope without rods". The horoscope figures are located in a separate strip underneath the constellation figures. We see the following figures in this strip (found on the right of the "bullfighting" scene): Venus (with a lioness and a crocodile underneath), an ape (additional symbol, possibly related to Venus), the Sun (a bird), Mercury, Jupiter, Saturn and Mars. Taken from [544], Volume 6, page 696.

horoscope with boats", qv in CHRON3, Chapter 13:4, where we study the issue meticulously.

Let us proceed with the interpretation of the dates transcribed in the horoscopes from Brugsch's zodiac.

2.1. The demotic subscript horoscope in Brugsch's zodiac

We hardly have anything to complement N. A. Morozov's analysis. We have verified all of his calculations very carefully; they proved perfectly correct, qv in CHRON3, Chapter 13:4.

Thus, the horoscope of demotic subscripts has two solutions – 1682 and 1861 A.D. However, we shall not reject the second solution like Morozov had done. Should it prove erroneous, it will be rejected automatically, once we estimate the dates from the two other horoscopes of Brugsch's zodiac. It will be most edifying to see whether the solutions shall be closer to the epoch of 1682 or that of 1861. After all, we must be prepared to any sort of surprises now that we know of the chaos reigning in the traditional version of Egyptian history and chronology.

2.2. The horoscope "without rods" from Brugsch's zodiac

Planetary figures of the horoscope "without rods" are presented as a separate strip in Brugsch's zodiac; we see it to the left of Nuit, where we found the demotic subscripts. We cite a close-in of a fragment of Brugsch's zodiac in fig. 18.4; see also the coloured version of Brugsch's zodiac compiled by the authors in fig. C12, where the planets are highlighted yellow.

We have conducted an extensive study of all the planetary figures from this horoscope in CHRON3, Chapter 15 – see also CHRON3, Chapter 15:4, or the section on the planetary symbolism of the primary horoscope. We shall refrain from reiterating the analysis, and merely formulate its result once again (see fig. 18.4).

The following scenes and figures from the primary horoscope are drawn in the zodiacal strip "without rods" (as shown in fig. 18.4, observed left to right):

1) The scene with the slaughter of a calf, or "bullfighting" ("corrida"), qv in CHRON3, Chapter 15:9.5.

2) The symbol of Venus – a lioness with a crocodile underneath, qv in CHRON3, Chapter 15:4.8.

3) A sitting baboon. We are uncertain about the exact meaning of this symbol; however, the information that we have at our disposal suffices to assume it to be an auxiliary symbol of the Sun or Venus; alternatively, it can represent the Moon. See more in re the possible identification of the baboon as a lunar symbol below, in CHRON3, Chapter 18:2.5. For the meantime, let us assume that the baboon represents one of the following:

3a) It might be an auxiliary symbol of the Sun, which is represented by the bird on the right. This interpretation is viable, since the figures of baboons ac-

companied the Sun drawn at sunrise or sunset in Egyptian symbolism ([1051:1], pages 45-46).

3b) Another option is that we are confronted with an auxiliary symbol of Venus. We see the planet right next to the sign, on its left. Indeed, we see the dusk/dawn symbol that looks like two little animals with their backs grown together; one of them is a similar baboon, qv in Chron3, Chapter 15:9.3 above.

Let us point out that since the figure of the baboon is located right in between the symbols of the Sun and Venus, both of the options mentioned above lead to the same interpretation of the zodiac "without rods", and therefore also a single astronomical solution thereof. Another possibility is that the baboon is a lunar symbol. This affects the interpretation of the horoscope to some extent, but we come up with the same solution nevertheless, qv in Chron3, Chapter 18:2.5 below.

4) The solar symbol that looks like a large bird. Such birds often stand for the Sun in Egyptian horoscopes, qv in Chron3, Chapter 15:4.13.

5) The figure of Mercury – a male with a human head, qv in Chron3, Chapters 15:4.2, 15:4.3 and 15:4.9.

6) The figure of Jupiter is a man with a simian head, qv in Chron3, Chapters 15:4.2 and 15:4.6.

7) The figure of Saturn looks like a man with the head of a jackal, qv in Chron3, Chapters 15:4.2 and 15:4.3.

8) Mars is represented by a male figure with the head of a falcon, qv in Chron3, Chapters 15:4.2 and 15:4.7.

A comparison of these symbols to the figures of constellations one finds nearby, in the adjacent zodiacal strip (see fig. 18.4) gives us the following horoscope.

The horoscope "without rods" from Brugsch's zodiac:

Sun in Virgo or Libra.

The Moon isn't drawn anywhere.

Saturn in Scorpio.

Mercury in either Libra or Scorpio. We find it in Libra, but it is possible that all four planets (Mercury, Jupiter, Saturn and Mars) are drawn in conjunction. All of them must therefore be in Scorpio.

Mars in Sagittarius or in Scorpio.

Venus in Leo.

Jupiter in either Libra or Scorpio.

The corresponding data file for the Horos application is cited in Annex 4.

The horoscope has a total of three solutions on the historical interval – 73 a.d., 250 a.d. and 1841 a.d.

Odd as it might seem, the only date that is close to the solution from the demotic subscript horoscope is 1841 a.d., no less.

Let us cite the precise positions of planets on the ecliptic for the solution of 1841 that we came up with for the horoscope "without rods". As usual, we specify the longitude of a planet on ecliptic J2000 in the first row of numbers underneath the names of planets, with the respective positions on the "constellation scale" provided below (see Chron3, Chapter 16:10).

Julian day (JD) = 2393762.00 <The horoscope "without rods">
Year/month/date = 1841/10/6 (old style) = 18 Oct 1841 a.d.

Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
207.2	254.1	270.5	259.4	271.1	174.5	229.9
5.80	7.58	8.11	7.76	8.13	5.00	6.69
Virgo	Scorpio	Sagitt.	Scorpio	Sagitt.	Vir/Leo	Libra

Average deviation from "best points" (sans Moon):
13.3 degrees.

However, let us refrain from jumping to conclusions and see what we learn from the third and final horoscope in Brugsch's zodiac – the horoscope "with boats".

2.3. The horoscope "with boats" in Brugsch's zodiac

The planets from the horoscope "with boats" as found in Brugsch's zodiac are also secluded in their own strip, likewise the planets from the previous horoscope, but to the other side from the figure of Nuit – to the right and not to the left. We cite a close-in of the related fragment of Brugsch's zodiac in fig. 18.5; see also the coloured version of Brugsch's zodiac in fig. C12, where the planets are highlighted in yellow, which was also the case with the zodiac above. Both zodiacs are located on different sides of the goddess Nuit, so as to keep the figures of the two from mingling and evade the otherwise inevitable confusion.

Fig. 18.5. A fragment of Brugsch's zodiac (BR) depicting the "horoscope with boats". Left to right: Mercury – Saturn – Mercury (the fast Mercury takes over the slow Saturn), the Sun (bird on a dais), Mars, Venus (already over the arm of Nuit in the other half of the zodiac) and Jupiter (reaching a hand out to Venus). Taken from [544], Volume 6, page 696.

All the planetary figures from the horoscope "with boats" were already studied above, in CHRON3, Chapter 15. This is also where we explain our choice of all the planetary identifications used herein. The reader can find more information on the subject in the respective subsection of CHRON3, Chapter 15:4, where we analyse planetary symbolism of primary horoscopes from Egyptian zodiacs. We shall simply quote the end result here.

We find the following planets in the strip that contains the "horoscope with boats" as seen in Brugsch's zodiac. We shall list them from left to right, in accordance with how we see them presented in fig. 18.5.

1) The first symbol from the left of the strip is a bird with a long beak and long legs is of an auxiliary nature and doesn't represent any planet.

2) Mercury is the man in a boat who's got a human head and a canonical planetary rod in his hand.

3) Saturn is the man in the boat with a bovine head and a pair of crescent-shaped horns; he is also holding a canonical planetary rod in his hand.

4) The second figure of Mercury is just like the first, but already shown on the other side of Saturn. What we see here is two figures of Mercury – one in the horoscope and the other next to Saturn. Alternatively, it could have "taken over" Saturn during the days covered by the horoscope.

5) The Sun is the bird on a dais. A similar bird with no dais underneath also stands for the Sun in the horoscope "without rods" on the other side of Nuit.

6) Mars is the man in a boat with the head of a falcon and a canonical planetary rod in his hand.

7) Venus is the woman in a boat holding a canonical planetary rod. It is drawn separately, over the arm of Nuit. The meaning might be that Venus had migrated towards the other half of the celestial Zodiac that we see on the left of Nuit – namely, the constellation of Sagittarius (however, it is possible that it is still drawn in Capricorn, qv in fig. 18.5).

8) Jupiter is the man in a tall headdress with a similar planetary rod. He is drawn giving his hand to Venus, drawn right next to the latter, over the arm of Nuit. We see no more figures further to the right – Jupiter is located at the very edge of Brugsch's zodiac.

A comparison of the symbols' disposition to the constellation figures in the nearby zodiacal strip (see fig. 18.5) shall give us the following horoscope.

HOROSCOPE "WITH BOATS" FROM BRUGSCH'S ZODIAC:

The Sun is in either Aquarius or Capricorn.

The Moon is absent from the horoscope.

Saturn in Aries.

Mercury is shown twice – in Pisces and in Taurus. It passes Saturn by.

Mars in Capricorn.

Venus is either in Capricorn, or already in Sagittarius, on the other half of the Zodiac.

Jupiter is in either Capricorn or Sagittarius.

The input data file for the Horos program that corresponds to this most noteworthy horoscope, which must finally tell us the date when Brugsch's zodiac was manufactured, are cited in Annex 4. Astronomical calculations demonstrate that the horoscope

"with boats" from Brugsch's zodiac only has two solutions on the entire historical interval, namely, 999 A.D. and 1853 A.D.

We are getting clear indications that Brugsch's zodiac dates from the XIX century! There is no other explanation to the fact that the dates of all three horoscopes only converge once on the entire time axis, their scatter range being minimal – 1841, 1853 and 1861 A.D. The date of the demotic subscript horoscope, which was apparently the last one transcribed in the zodiac, is indeed the most recent one of the three – 1861.

We must point out that there are very few possible solutions for each of the three horoscopes from Brugsch's zodiac – one to three of them on the entire historical interval. Therefore, the chances that they might converge in one point randomly are all but nonexistent. Since they did in fact converge, all we can do is admit that we have finally discovered the correct dating of Brugsch's zodiac in the second half of the XIX century.

Let us specify exact planetary positions on the ecliptic for the 1853 solution of the "horoscope with boats".

Julian day (JD) = 2397912.00 <The horoscope "with boats">
Year/month/date = 1853/2/15 (old style) = 27 Feb 1853 A.D.

Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
340.9	210.2	45.0	263.9	333.9	321.7	341.9
10.67	5.87	0.74	7.91	10.25	9.72	10.73
Aquar.	Virgo	Aries	Scorp.	Aqua/Cap	Capric.	Aqua/Pisc

Average deviation from "best points" (sans Moon):
26.5 degrees.

Let us provide some explanations for the solution.

1) Mercury was in Aquarius. However, it had been at a mere five degrees from the cusp of Aquarius and Pisces. Therefore, according to our rule that the borders between constellations can be crossed by 5 degrees maximum due to a certain vagueness in the definition of said borders, qv in CHRON3, Chapter 16. The position of Mercury in the solution of 1853 still conforms to the specifications of the "horoscope with boats". However, if we're to turn to the copy of Brugsch's zodiac, we shall see that Mercury may well

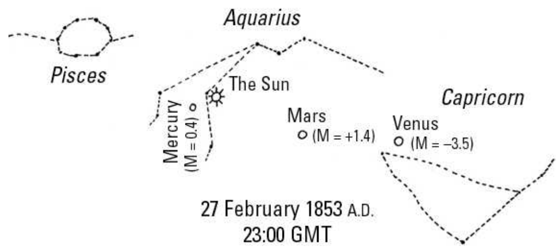


Fig. 18.6. "Horoscope with boats" from Brugsch's zodiac (BR). The celestial disposition of the planets that wound up in the vicinity of Aquarius on 27 February 1853 A.D. (15 February in the Julian calendar). Calculated in Turbo-Sky. The drawing is approximated.

have been in Aquarius near the cusp with Pisces, qv in fig. 18.5. Its figure is close enough to Aquarius. Let us point out that Mercury was invisible in the sky that day, since it had been too close to the Sun. The disposition of the Sun, Mercury, Mars and Venus on the celestial sphere for 27 February 1853 is shown in fig. 18.6.

2) It turns out that the second figure of Mercury that we find in a boat on the left of Saturn isn't part of the horoscope. However, it must mean something – most likely, the "meeting" of Mercury and Saturn. Indeed, when Mercury was passing Saturn by in 1853, they had been very close to one another. The distance between the two only equalled some 30 minutes on 30 May 1853 (Gregorian calendar). Both Saturn and Mercury were visible in Cairo at dawn quite well, since they rose on 30 May 1853 at the solar submersion rate of 9-10 degrees; it was dark enough for even the less bright stars to be visible ([393], page 16). Both planets had high luminosity levels – +0.2 for Mercury and +0.7 for Saturn on the photometric scale, which made them look like stars of the first magnitude. Their conjunction was therefore visible perfectly well in the sky at dawn.

3) The average deviation from the "best points" in the 1853 solution proved to be rather tangible – circa 27 degrees. It is acceptable, nonetheless. Bear in mind that the precision of Egyptian zodiacs cannot be higher than half of a zodiacal constellation's longitude, or 15 degrees on the average. Therefore, the average discrepancy between the calculated planetary positions and their approximate "best points" as spec-

ified by the actual zodiac can occasionally equal 20-30 degrees, which is possible if the zodiac wasn't drawn very accurately. One might well assume that Egyptian zodiacs didn't all conform to the same standards of accuracy.

For the sake of completeness, let us also cite the planetary positions from the second solution of the horoscope "with boats" – 14 February 999 A.D.

Julian day (JD) = 2085987.00 <The horoscope "without rods">
Year/month/date = 999/2/14

Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
344.9	289.1	49.0	265.7	322.6	301.6	.4
Aqua/Pisc	Sagitt.	Aries	Sco/Sag	Capric.	Cap/Sag	Pisc/Aqua

Average deviation from "best points" (sans Moon):
13.5 degrees.

This solution corresponds to the disposition of planetary figures in the horoscope "with boats" from Brugsch's zodiac – however, it lies at too great a distance from the possible solutions of the two other horoscopes in the same zodiac. The temporal gap between them equals more than 600 years, which is perfectly unacceptable for funereal horoscopes from the same coffin lid. The dates from a coffin must be close to each other. We must therefore stop at the solution of 1853, which – and we must stress this specifically, also corresponds to the horoscope "in boats" quite satisfactorily.

However, it becomes clear why neither of the "original" horoscopes (as opposed to the subscripts) from Brugsch's zodiac contains the moon. Indeed, we might recollect that the Moon was absent from both the zodiac "without rods" and the one "with boats". The horoscopes in question date to the XIX century, when the fact that the Moon is a satellite of the Earth and not a planet had been known widely enough, whereas in ancient astronomy the Moon always ranked amongst planets.

Indeed, we have seen that the compilers of the authentically old Egyptian horoscopes always tried to include the Moon, whereas their XIX century descendants could already "neglect" it, having learnt of the fact that the Moon wasn't really a planet from textbooks on astronomy.

2.4. Corollaries

We are therefore led to the conclusion that Brugsch's zodiac was manufactured in the second part of the XIX century. Brugsch's acquaintance with the zodiac took place shortly afterwards; he was careless enough to have mistaken it for an "ancient" specimen of Egyptian funereal art. The "demotic horoscope" must have been inscribed in the zodiac right before it was shown to Brugsch. Also, it was most probably calculated for a date in near future. It was a simple enough task in the XIX century – one would simply need some astronomical reference book, and those could be purchased in any shop. The "ancient" demotic names of planets could be copied from the works of the very same Brugsch, for instance, or one of his fellow Egyptologists.

By the way, "ancient" Egyptian coffins such as the one found by Brugsch can be seen in almost every large museum. However, their lids are hardly ever shown to us from the inside at all – and this is where the funereal zodiacs were drawn most frequently. Apparently, it's safe enough to view them from the outside, whereas the reverse remains taboo for some reason. Some of the historians who work as museum consultants must have read Morozov's works and realised that these zodiacs are best left beyond the reach of the general public, lest the latter might begin to ask uncomfortable questions about the Scaligerian version of Egyptian history and chronology. Egyptologists must value their quite lives spent in solving the "insoluble riddles of the Ancient Egypt" high enough.

2.5. The version with the baboon representing the moon in the "horoscope without rods"

In the present section we shall study the above-mentioned interpretation version of the "horoscope without rods" from Brugsch's zodiac where the sitting baboon represents the Moon and not the Sun, qv in fig. 18.4. The interpretation shall remain the same in every other respect, and so the end answer is unlikely to be affected much. Nevertheless, the considerations that we voice below might prove crucial for the dating of other Egyptian zodiacs that we haven't had the chance of studying as to yet, ones whose symbolism is identical to that of Brugsch's zodiac.

Fig. 18.6a. Ancient Egyptian figurine of a sitting baboon with a crescent and the solar circle on his head. Egyptologists are of the opinion that this baboon represented Thoth, the Egyptian lunar god. Taken from [1215:1], page 86.

Above, in our analysis of the "horoscope without rods" from Brugsch's zodiac, we were of the opinion that it doesn't contain the Moon at all. However, it was noted that the baboon figure in the horoscope might stand for the missing Moon, qv in fig. 18.4. We couldn't identify the baboon as a lunar symbol, since we found no such precedent in any of the zodiacs that we had studied previously.

Let us turn to other "ancient" Egyptian artwork that doesn't necessarily relate to zodiacs of any kind and see whether we can find a similar baboon figure, and, if so, its usual context. It turns out that the symbol of a baboon (known as *cynocephalus*, or the ape with a canine hear) is known rather well to Egyptologists ([1051:1], pages 45-46). It is indeed used as a solar and lunar symbol ([1051:1], pages 45-46; also [1215:1], page 86). For instance, it is presumed that these baboons accompany the Sun at dusk or at dawn in Egyptian symbolism ([1051:1], pages 45-46). On the other hand, the very same baboon is considered "the Egyptian Moon god" ([1051:1], pages 45-46; also [1215:1], page 86). Once again we witness the fact that Egyptian solar and lunar symbols would often resemble each other to the extent of being indistinguishable.

Furthermore, we discover that the Egyptian baboon (or cynocephalus) would often be drawn with a crescent and a circle over its head – solar and lunar attributes, in other words. Corresponding references are found in [1215:1], page 86, [1378:1], page 64, [1009:1], page 151, and also [1291], Tables 29(b) and 33(c). One of such drawings was cited in fig. 18.6a. Sometimes we find no such symbol on the head of the baboon, which is the case with Brugsch's zodiac; however, in such cases we usually find a solar figure close nearby. For instance, in the so-called "Tomb of Sennedjem" (the Luxor necropolis) we find drawings of two baboons similar to the ones from Brugsch's zodiac, sitting on either side of the solar boat as if they were protecting it, or merely serving as members of its entourage, qv in [1378:1], page 170, and [1009:1], page 200.

Thus, we see that the baboon was related to either the Sun or the Moon in Egyptian symbolism. As for Brugsch's zodiac, we already considered the possibility of identifying the baboon as a secondary solar figure above. Let us now see what result we shall get with the version where the baboon identifies as the Moon. Bear in mind that we're referring to the horoscope "without rods" from Brugsch's zodiac.

If the baboon is a lunar symbol, we shall get the following particularised interpretation of the horoscope. It coincides with the above completely, the only exception being that before we didn't specify the position of the Moon on the ecliptic, whereas now it is defined by the figure of the baboon. Therefore, the Moon must be located in Leo or in Virgo, qv in fig. 18.4. It is natural that the number of solutions can only diminish, since we introduce additional conditions. However, we already found a satisfactory solution, and a unique one, at that – 1841 A.D. Thus, all we need to do is verify the position of the Moon in the solution. It turns out that the new conditions are met as well; the best date is shifted by a mere two days – from the 6 to the 4 October 1841 (as usual, all the calculated dates are given in accordance with the Julian calendar).

Let us cite the source data and the planetary positions for the more precise solution of the horoscope "without rods" with the lunar position accounted for.

THE HOROSCOPE "WITHOUT RODS" INCLUDING THE MOON:

Sun in either Virgo or Libra.
Moon in either Leo or Virgo (sitting baboon).
Saturn in Scorpio.
Mercury in either Libra or Scorpio.
Mars in either Sagittarius or Scorpio.
Venus in Leo.
Jupiter in either Libra or Scorpio.

Calculations demonstrate that the same horoscope with the lunar position and the planetary order accounted for retains the same three solutions on the entire historical interval, namely:

19 October 73 A.D.;
13 October 250 A.D.'
4 October 1841 A.D.

We use a single day out of the few that fit the conditions of the horoscope for each solution. All the dates are Julian; bear in mind that the Julian date of 4 October 1841 corresponds to the Gregorian date of 16 October 1841, since the difference between the two calendars equalled 12 days in the XIX century.

The solution of 1841 is presented in fig. 18.6(b), which is where we see planetary positions for the morning of 4 October 1841 A.D. (equalling 16 October in the Gregorian calendar).

One needs to make the following observations in re the solution.

1) The Moon was new that night, and therefore invisible. It is little wonder, then, that the position of the Moon in the horoscope "without rods" corresponds to the last moment of its visibility in the morning of 1 October 1841. Since the moon was invisible on the two nights between the 2/3 and 3/4 October, this "shifted" position of the corresponding figure in the horoscope is easy to explain and also quite natural. We cannot expect the ancient Egyptian zodiacs to contain positions of invisible planets calculated with precision. Our analysis of the Egyptian zodiacs demonstrates that the compilation of regular funereal zodiacs did not involve complex astronomical calculations. Au contraire, in case of the monumental temple zodiacs one gets the feeling that their manufacture was accompanied by complex calculations aimed at raising precision.

2) Saturn and Mars were virtually at the same longitude in the solution of 4 October 1841, but their

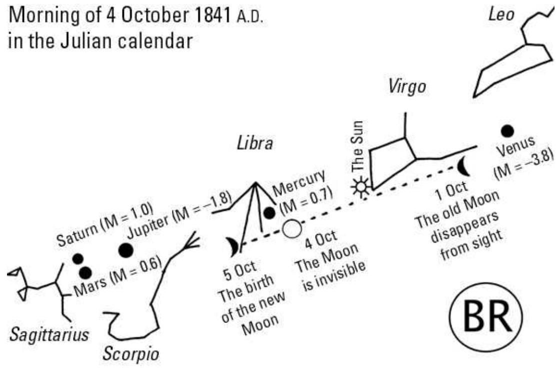


Fig. 18.6b. The solution of the "horoscope without rods" as seen in Brugsch's zodiac, with the Moon accounted for. We see the planetary positions for the morning of 4 October 1841 A.D. (16 October in the Gregorian calendar). The Moon was invisible that night, likewise the night before. Brugsch's zodiac indicates the last visible position of the Moon. The respective latitudes of Saturn and Mars all but coincided. Calculated in Turbo-Sky.

latitudes differed from each other drastically, qv in fig. 18.6b. Therefore, the exact order of Mars and Saturn on the ecliptic was extremely different to estimate from either observations or approximate calculations. The implication is that their order in the zodiac is likely to be arbitrary.

Let us conclude with citing the precise ecliptic longitudes of the planets for the solution of 4 October 1841. As usual, the first row of numbers underneath the names of the planets contains planetary longitudes for the ecliptic J2000. We find the respective planetary positions on the "constellation scale" as described in CHRON3, Chapter 16:10 right below.

Julian day (JD) = 2393760.00 <Horoscope "without rods">
Year/month/date = 1841/10/4 (old style) = 16 October 1841.

Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
205.2	228.1	270.4	259.1	269.7	172.0	227.4
5.75	6.60	8.11	7.75	8.09	4.92	6.56
Virgo	Libra	Sagitt.	Scorpio	Sagitt.	Leo (inv.)	Libra

Average deviation from the "best points": 10.5 degrees.

COROLLARY. The solution of 1841 for the horoscope "without rods" that we came up with above

satisfies to the zodiacal data perfectly well if the sitting baboon is a lunar symbol, which corresponds to its interpretation in literature on Egyptology. The most fitting date becomes shifted from the 6 to the 4 October 1841 (18/16 October in the Gregorian calendar, respectively), and the average deviation of the planets from their "best points" falls from 13 to 10 degrees, including the Moon this time. Once again, the excellent quality of the solution obtained is confirmed insofar as planetary positions are concerned.

3. THE "COLOUR ZODIAC FROM THEBES" ("OU")

Let us now turn towards "OU", the coloured zodiac from Thebes as shown in fig. 12.3.

The zodiac was discovered by the participants of the Napoleonic expedition into one of the sepulchres in the "Valley of the Kings" in Egypt. It is likely to have looked like a coloured fresco on the ceiling of the sepulchre. The zodiac was copied by the Napoleonic artists and published in the "Egyptian album" ([1100]), accompanied by the following inscription in French: "Tableau astronomique peint au plafond du 1er tombeau des rois à l'Ouest". The copy of the OU zodiac that we have used comes from this very album.

Above, in Chapter 17 of CHRON3 we already mentioned the royal Egyptian necropolis in the "Valley of the Kings", where the zodiac in question was found. Bear in mind that the temples of Dendera and Esna where the abovementioned zodiacs were found are also located near the same valley. As we have witnessed, the dates they contain relate to the epoch of the late XII – XV century A.D. The date transcribed in the Theban coloured zodiac OU, which was discovered in the actual Valley, would be most edifying deciphered and compared to the ones from the zodiacs of Dendera and Esna.

Let us proceed with the analysis of the zodiac. We must point out that we appear to have been the pioneers here, since we know of no earlier attempts of deciphering and dating the coloured zodiac of Thebes.

The Theban coloured zodiac OU has two halves, each of them a procession-like row of figures with a "goddess Nuit" of its own, qv in fig. 12.3. In one half of the zodiac, human figures have circles over their heads. In accordance with fig. 12.3, we shall be referring to this half as the top. The other half, whose figures have no circles over their heads, shall be known as the bottom half of the OU zodiac. As we shall see below, the primary horoscope of the coloured zodiac from Thebes is concentrated in the bottom half. The top half hardly contains any vital data at all. All we see here is the additional "bullfight" scene with the slaughter of a calf that we mentioned in CHRON3, Chapter 15:9.5, as well as a simplified duplicate rendition of the horoscope from the bottom half.

3.1. Constellation figures

In the centre of the zodiac's bottom half we see an agglomeration of figures; among them we instantly recognize the constellations of Leo, Scorpio and Taurus that look the same as they do in other Egyptian zodiacs.

Leo is drawn as an incumbent lion whose tail is stretched out; we see a tiny figure of Scorpio underneath. Likewise Leo, Scorpio is drawn with perfect precision. Furthermore, we see a man who holds something that resembles a dish or a tray in his hand underneath Taurus. We have therefore identified three constellation figures out of twelve. However, we don't recognize any members of their kin, which means the latter either look different, or were eschewed altogether.

We must point out that although it is of no importance to our further analysis, the nine remaining constellations are apparently present in the zodiac; however, they're drawn in a very abstract and unusual manner. Take a closer look at the figures from the left half of the bottom row. We see nine human figures here, one of them female. The bodies of the male figures are covered with dots of some sort; they resemble constellations, whose stars are also represented by dots in star charts, a great deal. These nine figures must therefore represent the remaining nine zodiacal constellations – Libra, Sagittarius, Capricorn, Aquarius, Pisces, Aries, Gemini, Cancer and Virgo. Obviously enough, the female figure (rightmost) represents Virgo. However, we must reiterate that their identity is of little importance to us, since there are no planetary symbols anywhere amongst the nine figures.

3.2. Planetary figures

Let us now try and locate the figures that represent planets. One should naturally expect to find them near constellation figures, since the very nature of a horoscope implies a certain distribution of planets across the constellations. Therefore, if the planetary symbols in our horoscope were at a great distance from the figures that stand for constellations, it would be impossible to determine the correct correlation, and the horoscope would cease to exist. If we are actually looking for a horoscope, we should expect to find planets right next to the constellations.

It has to be noted that there are no other symbols except for the actual figures anywhere in the abovementioned part of the horoscopes that contains the alleged constellation figures covered with dots. We see nothing remotely resembling a planetary symbol except for the inscription near the head of the woman that must stand for the constellation of Virgo, qv in fig. 12.3.

Planetary figures are however present next to the "real" constellation figures – Leo, Scorpio and Taurus. First of all, let us consider the three men in the bottom row, to the right from Leo's tail. The one in front simply touches the very tip of the lion's tail; all three have inscriptions next to their heads and point at something with their hands. They are followed by a few more male figures, whose hands aren't pointing at anything, and there aren't any inscriptions nearby, which must imply that the figures are silent, unlike the previous three that are clearly talking. Whatever it is that they're saying must be written next to their heads. They might be pronouncing the names of certain planets, as well as pointing at them. The planets must be "male", according to the figures that represent them.

Therefore, if there really is a horoscope in the zodiac, we must find three male planets in Leo or near Leo's tail (in Virgo, close to the border with Leo). Apart from that, we are beginning to realise that most of the planets we find in this zodiac have inscriptions next to them. Therefore, we must notice the presence of the latter in our search for the other planets.

We instantly find Venus – the only "female" planet. It must be represented by the female figure over Leo that also has an inscription next to its face. One cannot help but notice that Venus wasn't included in the general group for some reason – it "looms over" the procession, as it were; we aren't quite certain as to what this should mean so far, but will mark this for later. We have witnessed it many a time that such details are hardly ever of a random nature and contain astronomical information of some sort, which will be clarified by the exhaustive and final solution.

The presence of Venus in Leo is by another symbol that we find here as well – the crocodile underneath Leo. We have already seen a similar pair of symbols in Brugsch's zodiac ("horoscope without rods"), where it stood for Venus in Leo. This must mean the same thing here, seeing as how the symbolism of Egyptian zodiacs conforms to certain general rules; otherwise it would be impossible to come up with any interpretations at all, let alone the extensive number of exhaustive solutions yielded in the course of our research. In other words, we are acting that all Egyptian zodiacs were using a uniform symbolic astronomical language. This language was naturally far from minimal, and could employ several symbols for referring to the same astronomical object. Nevertheless, a similar set of symbols encountered in the same constellation would mean the same thing in the most diverse zodiacs.

Therefore, the coloured zodiac from Thebes is telling us Venus was in Leo; there were four planets altogether in Leo or the part of Virgo that is the closest thereto, near the lion's tail. Let us try to estimate the identity of these planets.

Let us consider the row of figures on the right of Leo once again. We see the abovementioned three men with inscriptions near their heads in front. Then we see another male figure without any remarkable attributes – he isn't making any gestures, and there are no inscriptions nearby. We also see three similarly unremarkable male figures at the very end of the procession. These figures are likely to have no particular meaning, and serve the purpose of filling the space; otherwise they would possess individual distinctive characteristics. If we are to disregard the four clones, we end up with three male figures that take part in the procession and have very explicit planetary attributes already known to us from other Egyptian zodiacs. One of them has got the head of a jackal, another has got the head of an ibis, a bird with

a long beak that is curved near the tip, and the third one has the head of a falcon. We know all of these attributes perfectly well, qv in Chron3, Chapter 15:4.2, 15:4.4 and 15:4.7. The head of a jackal or an ibis is an attribute of Mercury or Saturn. Bear in mind that Saturn has got the head of an ibis in the Lesser Zodiac of Esna, while Mercury has the head of a jackal in the Greater Zodiac. See Chron3, Chapter 15:4.3 for more details. Finally, a falcon's head is the most usual attribute of Mars in Egyptian zodiacs, qv in Chron3, Chapter 15:4.7.

Thus, we see Mercury, Saturn and Mars either in Leo or in Virgo closer to Leo.

It has to be pointed out that the confusion between Mercury and Saturn that can arise from similarity in their symbolism (see Chron3, Chapter 15:4.4) are of little to no importance in the present case, since we see both planets in the same constellation – namely, Leo.

The only planets that remain are the Sun, the Moon and Jupiter. We shall try to find them.

Right underneath Leo, between the lion and the crocodile, we see the constellation figure that represents Scorpio. Since we see a "real" constellation here, Scorpio must house a planet (or several planets). We realise that the concept of the Theban coloured zodiac implies that only the constellations that contain planets are represented explicitly, whereas others are either missing altogether, or drawn very schematically.

In this case, there must be some planetary symbol near Scorpio. Indeed, we see a hieroglyphic inscription that resembles a semicolon to its left, and a very explicitly drawn crescent. The disposition of the crescent and its small size that corresponds to the size of Scorpio (and not Leo) is a direct indication that the Moon was in Scorpio. If we are to look at the crescent through a magnifying glass, we shall see that it is really a small crescent-shaped lizard.

Thus, the Moon is in Scorpio.

The planets that remain are the Sun and Jupiter. It is easy enough to locate them, since there are no other options left. Since we see Taurus here, it must house either Jupiter or the Sun. The latter cannot be in Taurus for purely astronomical reasons – it would be at too great a distance from Mercury and Venus otherwise (we have already seen that the two were in Leo, separated from Taurus by two full constellations, Gemini and Cancer, occupying around 50 degrees of the ecliptic on the whole). Neither Venus nor Mercury can ever be found at this great a distance from the Sun. This means that Jupiter was in Taurus. It is drawn as a male figure that holds the symbol of Taurus high above its head on a tray. The corresponding inscription can be found at the level of Taurus – a little to the left, but further right than the two fantasy monsters that mark the boundary between the primary horoscope's scene as discussed presently and the "schematic constellations", or figures covered with dots. The inscription consists of three hieroglyphs and a bird underneath them.

Now we just need to find the Sun. However, there's just a single inscription left in the zodiac – several hieroglyphs and a bird that we see over the head of the woman at the very edge of the row of dotted figures, qv in fig. 15.49. The figures in question were hypothetically identified as "empty" constellations that contain no planets of the horoscope, whereas the actual female figure became identified as Virgo. We are therefore informed that the Sun was in Virgo.

Virgo is in the row of the "schematic" constellations for some reason, and not in the part of the horoscope where we find all the "real" constellation figures and all the rest of the planets. However, its figure isn't covered in dots, which makes it very unlike the rest of the figures in the row.

The position of the Sun in Virgo corresponds with the fact that Venus and Mars were in the neighbouring constellation of Leo perfectly well. The two other possibilities for the Sun (Leo and Cancer) that don't contradict the location of Mercury and Venus aren't confirmed by the actual zodiac in any way and are therefore considered redundant.

Moreover, the coloured Theban zodiac contains more indirect evidence to the fact that the Sun was in Virgo or close nearby on the date transcribed in the horoscope, but neither in Leo, nor in Cancer. Let us wonder why the figure of Taurus is raised high upon a tray? From the astronomical point of view, this must refer to the constellation reaching its culmination, or the highest possible point of the celestial sphere. As we already explained in Chron3, Chapter 15:4.13, the culmination of Taurus indicates that the Sun was on the opposite side of the ecliptic, and could be in

Virgo, Libra, Scorpio or Sagittarius; Cancer and Leo are right out.

We can therefore be certain that the Sun is shown in Virgo.

3.3. The primary horoscope and the extra conditions

Our decipherment of the horoscope from the Theban coloured zodiac ends here. We have discovered all seven planets of the antiquity – the Sun, the Moon, Mercury, Saturn, Jupiter, Mars and Venus. All of them proved to be distributed across their respective constellations evenly. All the hieroglyphic inscriptions found in the zodiac were accounted for; there are seven of them, one for every planet.

It turns out that the entire horoscope is concentrated in the bottom half of the coloured zodiac from Thebes. There isn't a single inscription in the top half; the figures we find there are simplified duplicates of the same scenes and symbols that one finds in the bottom half. Thus, we see Mercury, Saturn and Mars right opposite the very same planets in the bottom row. The figures and the positions of their arms remain the same, but there are no inscriptions. Venus is represented by the pair of the lion and the crocodile, without a separate female figure. Jupiter is a one-armed figure accompanied by a very approximated drawing of Taurus. The lunar lizard is under the paw of the fantasy beast. The Sun is nowhere to be found, likewise the constellation of Virgo that housed in. However, one still sees an obvious similarity between the figures from the top row and the ones in the bottom row that oppose them.

Therefore, we aren't likely to find anything new apart from what we already found in the bottom row. We should therefore consider the primary horoscope sufficient; in the present case, we managed to interpret it fully.

The horoscope is as follows:

Sun in Virgo;

Moon in Scorpio;

Mercury, Saturn, Mars and *Venus* in Leo or Virgo, close to the border with Leo (near the "lion's tale", in other words);

Jupiter in Taurus.

The coloured Theban zodiac demonstrates a paucity of additional astronomical data. We neither find any secondary zodiacs here, nor planetary visibility indicators.

The order of planets isn't defined rigidly; the additional "bullfighting" scene ("corrida") with the slaughter of a calf is of no use to us in filtering out the extraneous solutions, as we already know.

Nevertheless, there is *some* additional information in the zodiac. More precisely:

1) Three planets (Mercury, Mars and Saturn) are drawn together in the zodiac, and the triad is distinctly separate from Venus. Therefore, the above-mentioned three planets must be arranged in a sequence on the ecliptic. The astronomical solution shall only correspond to our zodiac well if the calculated position of Venus sets it apart from the other three planets.

2) The unusual sideways disposition of Venus is distinctly emphasised in the coloured zodiac of Thebes. From the astronomical point of view, this is most likely to mean that Venus drifted away from the ecliptic considerably, whereas the other planets formed a row that was parallel to the ecliptic. Venus lay to the side as a result, away from the line.

Thus, we have a total of two extra conditions for the verification of our horoscope's solutions. Our chances of getting an unequivocal answer are therefore far from great. However, let us refrain from despairing prematurely; the quantity of preliminary solutions available on the historical interval shall be decisive. We shall turn to astronomical calculations for answers.

The input data file for the Horos program that correspond to the horoscope are cited in Annex 4.

3.4. Preliminary solutions of the primary horoscope

Astronomical calculations demonstrate that the above horoscope has very few solutions on the interval between 500 B.C. and the present era. There are only three of them:

16 August –349 (350 B.C.);

30 August 268 A.D.;

6 September 1182 A.D.

We have given a single date for each solution to keep things simple; in reality, the horoscope's condi-

tions were satisfied to for intervals of several dates that included the ones cited above.

Let us make a brief digression and mention the method used for referring to the years before Christ in the present book. There are two such methods, generally speaking. The one we're adhering to presently is the so-called "astronomical method" that contains year zero. The other method, known as "historical", contains no such year – 1 A.D. is preceded by 1 B.C. Thus, "year zero" as used in the astronomical method corresponds to the year "minus one" of the historical method, or 1 B.C. Therefore, the numbers of all years before Christ are shifted by one.

So, when we write "year –349" (astronomical method), it corresponds to the historical year 350 B.C. As a rule, the historical method is used in literature; however, astronomical literature is more likely to use the astronomical method, since the other one is less convenient for calculations. One needs to be careful with astronomical software that performs calculations. Some programs use astronomical years by default, whereas others use the historical method. Moreover, the indications used are exactly the same – the years before Christ are preceded by a minus sign. The Turbo-Sky program, for instance, uses the historical method; therefore, the year of our first solution (–349 in the astronomical system) shall become the year –350 in Turbo-Sky. If the readers intend to use some other astronomical software for calculations of their own, they have to find out about the method it uses for referring to the years before Christ. It can be done in the following manner: try specifying year zero as the date of observations. Should you succeed, the software uses the same method as the authors of the present book. Alternatively, it shall employ the historical method, in which case the values of all the years preceded by a minus sign in our book shall have to be reduced by one.

Let us return to the coloured zodiac from Thebes. We stopped at the choice of three solutions for its horoscope on the entire interval between 500 B.C. and the present, namely, –349, 268 and 1182.

The fact that there are so few solutions gives us hope that we can arrive at an unambiguous dating for our zodiac. Let us emphasise that the three solutions mentioned above are of a preliminary nature, and weren't tested for correspondence to extra specifications. Only the solutions that can withstand the test successfully shall be considered final. If it turns out that there's just a single finite solution, we shall consider the date as transcribed in the zodiac to have been estimated without ambiguity. Below we shall witness this to be the case. The date transcribed in the coloured zodiac from Thebes can indeed be reconstructed unambiguously as 5-8 September 1182 A.D.

Let us cite precise planetary longitudes on the ecliptic for each of the preliminary solutions mentioned above. As usual, we give planetary coordinates on the ecliptic J2000 in the first row underneath the names of the planets, and planetary positions on the "constellation scale" in the second row, qv in CHRON3, Chapter 16:10. Below we see the names of the zodiacal constellations that housed the planets. If a planets winds up on the cusp of two constellations, it is always specified explicitly (for instance, Sag/Sco means that the planet was on the cusp of Sagittarius and Scorpio).

Julian day (JD) = 1593813.00 <preliminary solution>
<350 B.C.>
Year/month/date = –349/8/16

Sun	Moon	Jupiter	Venus	Saturn	Mars	Mercury
170.0	267	58	143	160	160	163
4.8	8.0	1.2	4.0	4.5	4.5	4.6
Leo/Vir	Sag/Sco	Taurus	Can/Leo	Leo	Leo	Leo

Julian day (JD) = 1819187.00 <preliminary solution>
<268 A.D.>
Year/month/date = 268/8/30

Sun	Moon	Jupiter	Saturn	Venus	Mercury	Mars
180.7	247.2	64.5	141.8	148.8	168.0	176.7
5.15	7.35	1.34	3.93	4.17	4.79	5.05
Virgo	Scorpio	Taurus	Can/Leo	Leo	Leo	Vir/Leo

Julian day (JD) = 2153032.00 <final solution>
<1182 A.D.>
Year/month/date = 1182/9/6

Sun	Moon	Jupiter	Saturn	Mercury	Mars	Venus
181.4	258.3	86.4	151.2	170.2	169.8	173.2
5.17	7.72	1.92	4.25	4.86	4.85	4.96
Virgo	Scorpio	Taurus	Leo	Leo	Leo	Leo/Vir

Now let us carry on with verifying the compliance of the solutions to additional criteria. We have formulated two of them above, see CHRON3, Chapter 18:3.3. Let us recollect them:

1) Mercury, Mars and Saturn must form a row on the ecliptic. Venus should be positioned separately from the group of three planets (Mercury, Mars and Saturn).

2) Venus should lay "sidewise" from the neighbouring Mercury, Mars and Saturn, or the general planetary line.

3.5. Verification by compliance to additional criteria

Let us begin with the first solution – 16 August – 349 (350 B.C. on the historical scale). Planetary positions as seen by an observer in Luxor are shown in fig. 18.7. We see the moment when Mercury rose, when the solar submersion rate equalled circa 7 degrees. Other planets (Venus, Saturn and Mars) had risen earlier, while it was still dark, and were in good visibility. Mercury may have been visible in Luxor at dawn; its luminosity equalled +0.2. We have selected Luxor as the observation point since Mercury could not be seen in Cairo, where it rose at the solar submersion rate of 5 degrees. See more in re the choice of possible observation points for Egyptian zodiacs in CHRON3, Chapter 15:11.

We must instantly note that the solution of –349 satisfies to the source zodiac rather approximately, since the Sun, which must be in Virgo according to the Zodiac, lingers at the edge of Leo; it will be in Virgo in a few more days. However, had the Sun been in Leo, it would be specified in the zodiac in some way; the leonine figure is present there, after all. However, there are no indications that the Sun was in Leo anywhere in the zodiac.

Let us now consider just how the auxiliary conditions (or additional criteria) are met. The first condition is that Venus must lay outside the group consisting of Mercury, Saturn and Mars; it is indeed met here, qv in fig. 18.7. However, the second condition about Venus located "sideways" on the zodiac already fails to be met in this solution, since Venus is in line with the rest of the planet on the ecliptic. There are no reasons to draw it perpendicular to the general planetary route according to the solution in question. And we remember the unusual position of Venus emphasised in the Theban zodiac; Venus is perpendicular to the general line of planets, and lays sideways.

This solution should therefore be rejected since it fails to comply with the additional criteria implied by our zodiac. We must also mention that the solution of 350 B.C. would be too early even from the Scaligerian point of view, according to which the earliest epoch when zodiacs with "Graeco-Roman" astronomical symbolism could appear in Egypt is the II century B.C. (see a discussion of this issue in CHRON3, Chapter 12). However, we see that the "Graeco-Roman" constellation figures are explicitly present in the coloured zodiac from Thebes (Leo, Scorpio and Taurus).

Let us try the second solution – 30 August 268 A.D. The planets were distributed across the ecliptic as follows:

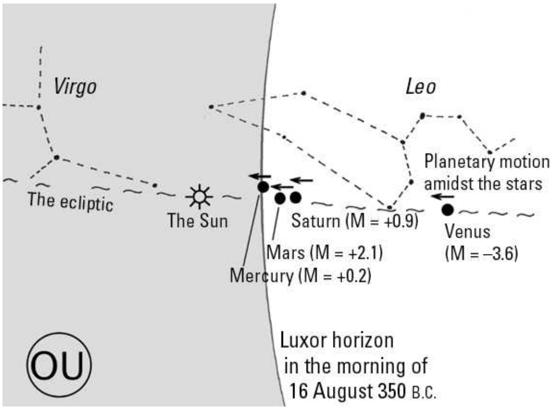
Sun	Moon	Jupiter	Saturn	Venus	Mercury	Mars
5.15	7.35	1.34	3.93	4.17	4.79	5.05
Virgo	Scorpio	Taurus	Can/Leo	Leo	Leo	Vir/Leo

One can instantly see that the solution doesn't satisfy to the first additional criterion – Venus wound up in between Saturn and Mercury. The planetary order in this solution is as follows: Saturn, Venus, Mercury, Mars and the Sun. This is clearly at odds with the zodiac where Mercury, Saturn and Mars are drawn at a certain distance from Venus. The planetary order as given in the solution under study will place Venus in line with Saturn, Mars and Mercury. Therefore, we must reject this solution as well, since it fails to demonstrate correspondence with the zodiac. Yet we managed to come up with an ideal solution for every other Egyptian zodiac; there should be one for the coloured zodiac from Thebes as well.

Indeed, the last preliminary solution that we found (1182 A.D.) corresponds to the zodiac perfectly. The best correlation between the zodiac and the solution was reached on the interval of 6-7 September 1182; however, this correlation is also valid for 5 and 8 September. Thus, the final and complete solution of the coloured Theban zodiac is as follows:

5-8 September 1182 A.D.

Planetary positions in the solar vicinity for the morning of 6 September are shown in fig. 18.8. We



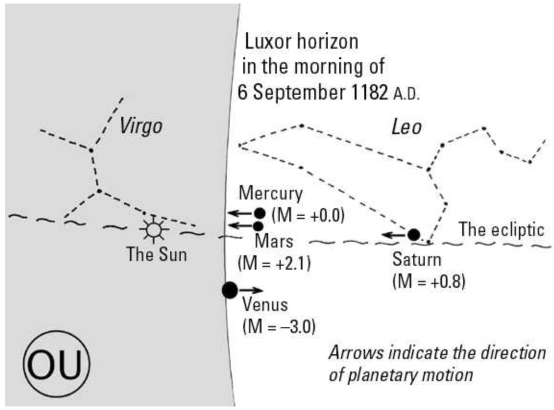


Fig. 18.7. A preliminary (incomplete) solution of the Coloured Theban Zodiac (OU). The morning sky before sunrise in Luxor on 16 August –349, that is, 350 B.C., on the moment when Mercury had risen at the solar submersion rate of 7 degrees. Mercury and Mars may have been visible that day, albeit badly. The dotted tilde line marks the ecliptic. One sees that all the planets, including Venus, are located almost directly on the ecliptic. Venus does not deviate from the general line of planetary motion across the ecliptic. Calculated in Turbo-Sky.

have once again chosen Luxor as the observation point. One sees that the Sun was indeed in Virgo that day, as the zodiac stipulates. Mercury, Mars and Saturn were in Leo – once again, just as it is shown in the zodiac (fig. 18.8). Venus was at the very edge of Leo, close to Virgo; the important fact is that it had drifted sideways from the ecliptic. It left the general planetary route and was located to the side, at the distance of some 5 degrees from the ecliptic – just as we see it in the zodiac. The other planets were more or less on the ecliptic, not deviating from it by more than one degree. Let us see what the solution of 1182 can give us.

1) The first additional condition is met, since Venus is indeed placed at some distance form the planetary group of Mercury, Saturn and Mars; it is shifted sideways from this group, in the direction of Virgo.

2) The second additional condition is also met, since Venus drifted away from the ecliptic and was located to the side from the general planetary route on the ecliptic.

Apart from that, the distribution of planets across constellations as suggested by the solution of 1182 A.D. corresponds with the zodiac ideally.

3.6. Corollary: the date transcribed in the OU zodiac is 5-8 September 1182 A.D.

We are brought to the conclusion that the date transcribed in the coloured zodiac of Thebes by the "ancient" Egyptians is really the interval between the 5 and 8 September 1182 A.D. – the same epoch as the dates of the Dendera zodiacs, right in between the dates of the Long and Round zodiacs from Dendera.

One gets the impression that Egyptian tradition ascribed a special meaning to the end of the XII century – possibly, due to the fact that some important events took place during that epoch. The events must have been of a holy nature, since their dates were written on the ceilings of cyclopean Egyptian temples. However, it is too early to make final conclusions, since the dates that we decipher from Egyptian zodiacs only reflect the opinion of their "ancient" authors on the chronology of ancient events; this opinion can just as easily prove true as false. Yet we can be certain

that these very "ancient" Egyptian authors lived in the XII century A.D. the earliest – most probably, a great while later.

We must note that our solution of the coloured Theban zodiac coincides with one of the holiest days in Christian tradition – the birth of Our Lady. The Orthodox Church celebrates it on 8 September (old style, or Julian calendar). The day is covered by the interval between 5 and 8 September 1182, which is the solution that we came up with for the zodiac. The correspondence may be of a chance nature; however, it is also possible that the date of a Christian feast was written on the ceiling of a royal tomb from the Egyptian Valley of the Kings.

This wouldn't be all that surprising, given all that we already know.

Fig. C10. The coloured version of the Upper Zodiac from Athribis (AV). Top of the zodiac. Based on the drawn copy from [1340:2]. The colours are represented by the following codes: *R* for red, *J* for yellow, *B* for blue, *G* for green and *BR* for brown.

Fig. C11. The coloured version of the Lower Zodiac from Athribis (AV). Bottom of the zodiac. Based on the drawn copy from [1340:2].

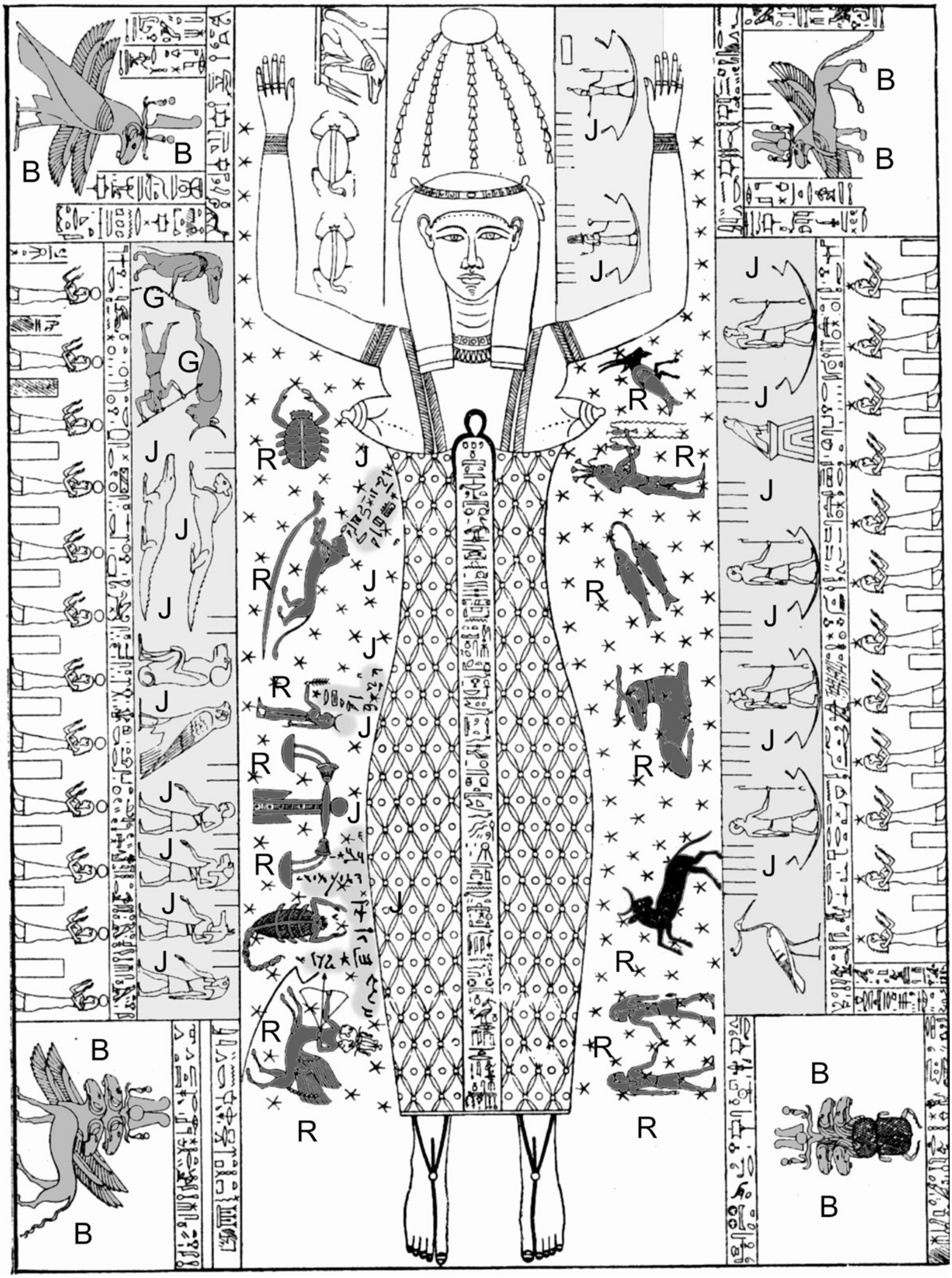


Fig. C12. The coloured version of Brugsch's zodiac (BR). The colour yellow marks all three individual horoscopes contained in the zodiacs; each one of them is an independent primary horoscope. They are as follows: the horoscope "without rods", the horoscope "with boats" and the demotic subscript horoscope. Based on the drawn copy from [544], Volume 6, page 696.

CHAPTER 19

Dating results for Egyptian zodiacs

1. THE GENERAL SITUATION WITH THE DATINGS OF THE EGYPTIAN ZODIACS

The full picture of how the dates ciphered in the Egyptian zodiacs that we studied are distributed temporally can be seen in fig. 19.1. Black circles stand for the zodiac with a single solution option, and white circles represent the ones with several possible interpretations; however, fig. 19.1 demonstrates that there are very few such cases.

We would usually come up with several versions for the "poor" zodiacs, by which we understand the ones lacking in secondary horoscopes and additional astronomical information in general. If it turns out that the primary horoscope of such a zodiac has got several interpretations, or cannot be deciphered unambiguously, there is no way to verify the solutions so as to choose the correct one.

Fig. 19.1 makes it perfectly obvious that the consensual chronology of the Ancient Egypt is most likely to be incorrect.

The dates of the zodiacs are telling us plainly enough that the ancient Egyptian history that we're familiar with from textbooks has got nothing to do with the era of several millennia before Christ, which is how modern Egyptologists date it, but rather the epoch of the XI-XVI century A.D. The gigantic Egyptian temples and pyramids are most likely to have been built in the XIV century A.D. the earliest; the dates inscribed in the zodiacs we find in these temples pertain to the XI-XVI century. However, this doesn't mean that the dates refer to built on the dates ciphered in the zodiacs; they were most probably built a great while later, since the temple artwork usually reflects events of the epochs that precede the construction of the actual temples.

As for the painted "ancient" Egyptian wooden coffins, the art of their manufacture had existed in Egypt until relatively recently, according to Brugsch's zodiac – namely, the middle of the XIX century. It is therefore possible that there are many genuine XIX century specimens among the coffins one finds exhibited in the Egyptian halls of modern museums.

Our datings of the ancient Egyptian zodiacs are as follows:

1) The Round Zodiac of Dendera – morning of 20 March 1185 A.D.

2) The Long Zodiac of Dendera – 22-26 April 1168 A.D.

3) The zodiac from the Greater Temple of Esna – 31 March – 3 April 1394 A.D.

4) The zodiac from the Lesser Temple (in the northern end of Esna) – 6-8 May 1404 A.D.

Flinders Petrie's zodiacs from Athribis:

5) The Upper Zodiac of Athribis – 15-16 May 1230 A.D.

6) The Lower Zodiac of Athribis – 9-10 February 1268 A.D.

7) The Theban Zodiac of Heinrich Brugsch turned out to contain three horoscopes at once; each one of them contains a date of its own:

7a) The demotic subscript horoscope – 18 November 1861 A.D.

7b) The horoscope "without rods" – 6-7 October 1841 A.D.

7c) The horoscope "with boats" – 15 February 1853 A.D.

8) The coloured zodiac from Thebes found in the Egyptian "Valley of the Kings and reproduced in the Napoleonic album on Egypt ([1100]: 5-8 September 1182 A.D.

9) The two zodiacs of Petosiris. Due to the paucity of additional astronomical data in these zodiacs, we came up with three possible solution options for these zodiacs, with the datings set apart by intervals of 100 years or less. We shall discuss the dating of these zodiacs in a separate publication.

9a) 5 August 1227 A.D. for the zodiac P1 from the outer chamber and 24-25 March 1240 A.D. for the zodiac P2 from the inner chamber;

9b) 10 August 1430 A.D. for P1 and 17 April 1477 A.D. for the zodiac P2 (the solution is somewhat imprecise in the latter case);

9c) 2 August 1667 A.D. for P1 and 2 April 1714 for P2.

Thus, it turns out that all possible datings of the zodiacs from the tomb of Petosiris date from the late Middle Ages.

We can now be quite certain when we claim that the events related to the "ancient" history of Egypt and the epoch of the Pharaohs really took place in the XI-XV century of the new era, and not several millennia before Christ, as it is presumed generally – a "mere" 400-1000 years ago, that is. Insofar as the grandiose temples of the ancient Egypt are concerned, the zodiacal dates they contain indicate at the epoch of the late XII – early XV century A.D.

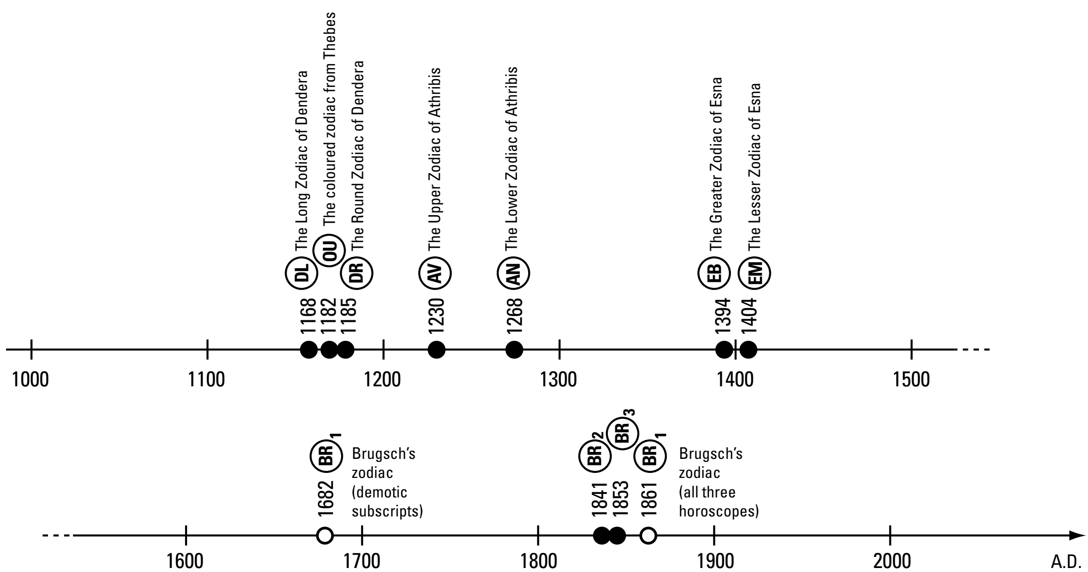


Fig. 19.1. The distribution of the dates found in the ancient Egyptian zodiacs across the time axis. Black circles stand for the dates that can be estimated unequivocally. Zodiacal abbreviations: DL – the Longer Zodiac of Dendera. DR – the Round Zodiac of Dendera. EB – the zodiac from the Greater Temple of Esna. EM – the zodiac from the Lesser Temple of Esna. AV – the Upper Athribis Zodiac of Flinders Petrie. AN – the Lower Athribis Zodiac of Flinders Petrie. OU – the Coloured Theban Zodiac from the Valley of the Kings near Luxor. BR – Brugsch's zodiac.

2. THE STABILITY OF THE DATINGS THAT WE CAME UP WITH

The stability of the datings that we got as a result of our research is one of their most important characteristics.

Firstly, all of the preliminary solutions that we got for the primary horoscopes were stable in minor details, insofar as small variations of the selected interpretation option were concerned. We have been very meticulous about making it absolutely certain that every set of preliminary solutions that we came up with for the fixed decipherment of the primary horoscope would be stable in face of minor variations concerning the understanding of the zodiac in question in the present decipherment. The intervals of possible planetary disposition across constellations were always chosen with enough give. If two planetary figures were located too close to each other on the zodiac and their respective order wasn't defined explicitly, this circumstance would invariably be accounted for in the search of astronomical solutions. In general, we tried to take all possible solutions for the zodiac under study into account, in every sensible interpretation.

Secondly, all the exhaustive solutions that we discovered are stabile as a whole, in general. That is to say, no variations in the interpretation of a given zodiac, no matter how great, could lead to the discovery of a second exhaustive solution for the same zodiac. This applies to the great temple zodiacs from Dendera and Esna primarily. The secondary horoscopes that they contain are detailed enough to exclude the possibility of an exhaustive random solution. Therefore, the stability of the exhaustive solutions that we came up with for the temple zodiacs from Egypt can be estimated as very high indeed. It is all the greater that both pairs of dates from the zodiacs found in Dendera and in Esna turned out to be very close to each other. The difference between the two dates from Dendera equals 17 years, said interval equalling a mere 10 years for the Esna dates. It is unlikely that such a coincidence could manifest randomly – and repeatedly, at that.

The stability of the dates that we deciphered from the less informative zodiacs owes a lot to the fact that they comprise pairs or even triads of closely related drawings (discovered in the same tomb, for instance). Thus, the datings transcribed in such pairs must be close to each other; this allows for highly reliable choice options of finite solutions from the multitude of preliminary ones.

Once again, we come up with mediaeval datings that fail to concur with the Scaligerian version of Egyptian history in any way at all. If all of the above is considered "random" and "chance", why don't we get any "random" datings from the I century A.D., for instance? Such datings would satisfy the Scaligerite Egyptologists – if they existed, which very clearly isn't the case here. Au contraire, we get dates from the same time interval, and those correspond to the New Chronology perfectly.

3. UNRESOLVED ISSUES IN THE DECIPHERMENT OF EGYPTIAN ZODIACS

The problem of interpreting the horoscopes in the zodiacs of the "Theban" type remains unsolved. We must remind the reader that such zodiacs often don't contain any drawings of constellations whatsoever; the groups of planetary figures in such zodiacs appear in cells that the zodiacs are divided into in some manner. We cited a few examples of such zodiacs above – the LZ zodiac as seen in fig. 12.1, and the RM zodiac from the ceiling of the tomb ascribed to "Ramses VI" in the Valley of the Kings, qv in fig. 15.25.

It is likely that planetary longitudes in such zodiacs are given in a different system, where the ecliptic is divided into other units than constellations, unlike the rest of the Egyptian zodiacs. These parts may well be equal – a propos, this is the system used by the modern astrologists, who divide the ecliptic into the twelve so-called "zodiacal signs" that only bear a very distant relation to actual zodiacal constellations. They simply divide the ecliptic into twelve equal parts, and use the names of zodiacal constellations for referring to them.

It is possible that some such system was used in the Egyptian zodiac of the Theban type. In the zodiac from fig. 12.1, for instance, the ecliptic is divided into 36 equal parts, as we already mentioned above. However, the exact nature of this division remains un-

clear; we know nothing of whether the entire ecliptic was divided into 36 equal parts, or whether each of the zodiacal constellations is divided into three parts, which yields the same number.

As for the figures from the other zodiacs of the "Theban" type, they have got a lot in common with the other Egyptian zodiacs. Therefore, the identification of planets in such zodiacs should conform to the same rules as with other Egyptian zodiacs in general, although the Theban zodiacs also have a number of peculiarities in this respect that complicate the interpretation.

Note of 2004. Egyptian zodiacs of Thebes type were completetely deciphered and dated by A. T. Fomenko and G. V. Nosovsky in 2003. Full details of this decipher are to be found in the 2nd expanded edition of "New chronology of Egypt" by A. T. Fomenko and G. V. Nosovsky (Mosocw, Vetche publishers, 2003, in Russian). Actually, astronomical language of Thebes class is truly unusual and differs remarkeably from roman zodiacs we are accustomed to. Our decipher of astrosymbolisms of Thebes class of zodiacs has produced datings for all pharaonic burials in the Valley of Kings disposing of burial zodiacs. Of those zodiacs ones attributed to Ramses VI, Ramses IV, Ramses IX were Thebes class and zodiacs of Ramses VII and Seti I were of Roman type. These dates extracted from burial zodiacs are listed below. We do not know about presence of zodiacs in any other burial chambers. In most tombs the zodiacs were scraped off, in others they were not painted at all.

4. ASTRONOMICAL DATING OF SUMERIAN TABLETS

Our account of the Egyptian zodiacs, our research thereof and the datings that we came up with ends here. It turned out that none of our datings confirms the consensual chronology of Egypt; on the contrary, they appear to be contradicting it, and quite explicitly so.

The readers might ask whether our results can correspond to the astronomical datings of the "extremely ancient" Sumerian tablets, since the latter are said to be easily and reliably datable with the use of astronomical methods, and presumably confirm the consensual chronology ([1287] and [1017:0]). Let us try and attain some clarity in the matter.

We shall use the astronomical edition of the texts contained in the Sumerian astronomical tables ([1017:0]). This work contains the English translations of several hundred Sumerian tablets, allegedly reliably dated to the period between 652 B.C. and 165 A.D.

Sumerian tablets refer to the presence of planets in zodiacal constellations; in other words, they contain horoscopes. The book ([1017:0]) contains a great number of dates that historians consider to be "implied astronomically" by the horoscopes from the Sumerian tables.

Needless to say, all of these dates fall into the framework of the consensual Scaligerian chronology and are said to "confirm" it perfectly. However, the picture becomes a great deal less idyllic once we begin to compare these dates to the original Sumerian texts that they were allegedly culled from, rather than Scaligerian chronology.

First and foremost, we must state that the texts of Sumerian tablets published in [1017:0] don't contain a single exhaustive horoscope that could lead to a unique solution on the entire historical interval. All the horoscopes found in these tables are incomplete a priori; they often contain nothing but information on three or four planets. Such horoscopes can yield solutions with datings falling on almost every century, as the readers can witness themselves with the aid of the Horos software. It is always possible to select the desired solution from this multitude that will correspond to Scaligerian chronology and "confirm" the latter. Historians are doing just this, and in a very sly manner, too.

Secondly, the texts of Sumerian tablets often omit the names of the planets – either altogether, or simply by containing references to "a certain planet". Just what planet the "ancient" Sumerian had in mind is naturally rendered to guesswork. For instance, these "guesses" can be made in any which way at all – whether or not they will concur with Scaligerian chronology only depends on the intention of whoever's making the guess (or any other chronological system, actually). All of this guesswork has got absolutely nothing in common with the astronomical dates yielded by independent methods.

Finally, the dates suggested by historians still fail

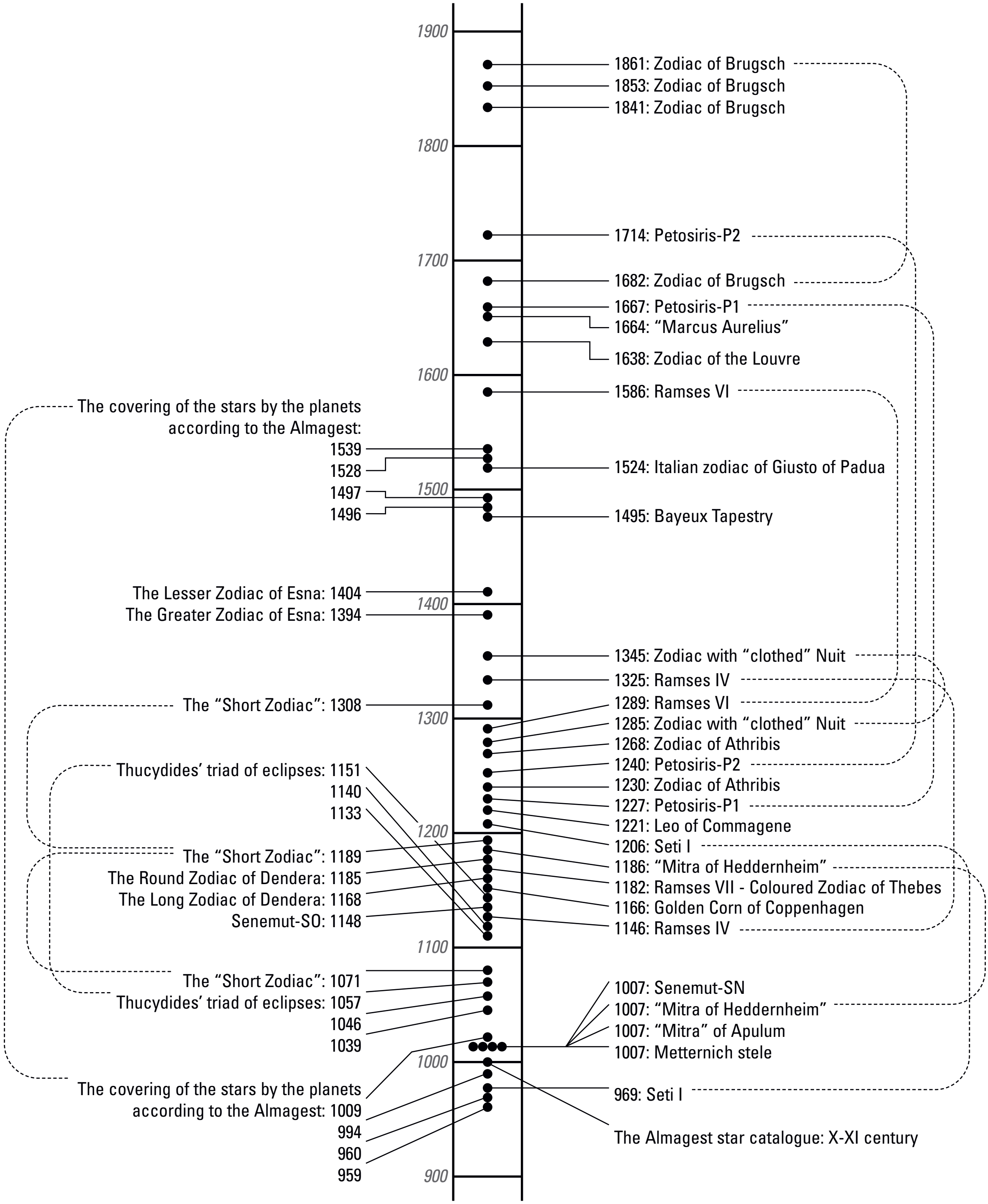


Fig. 19.2. Consolidated table of astronomical datings obtained by the autors, including those of ancient zodiacs with horoscopes. In case of multiple astronomical solutions, the latter were linked up by dashed lines.

to correspond with the astronomical content of the Sumerian tablets. The "plight" usually begins whenever the tablet under study contains a more or less detailed horoscope, which naturally makes it easier for the historians to make it fit the desired answer.

Let us just cite a single example of the above. We are referring to the tablet numbered 418, dated to the 5th year of Darius II:

"The dating … that we agreed upon herein is based on planetary descriptions (Jupiter in Leo, Venus and Mercury in Taurus, and Saturn in Cancer) … This dating unfortunately fails to be confirmed … [this is followed by complaints about the fact that the "ancient" Sumerian author "misnames" the king who was his contemporary and should be identified as Artaxerxes according to the dating as well as Scaligerian chronological tables – Auth.] … Worst of all, Venus was invisible, whereas … it is referred to as the "morning star" in the first observation. In the third observation, the reference to the "northern horn" indicates that the Moon should … unfortunately … the latitude of the Moon had roughly equalled +3 degrees when it was passing by the Delta of Capricorn …" ([1017:0], Volume 1, pages 60-61). And so on, and so forth.

The above fragment gives a good impression of just how low the precision of correspondence is between the astronomical descriptions of the Sumerian tablets and the Scaligerian datings ascribed thereto. This "precision" rate can hardly be called satisfactory – all of this considering how the horoscope in question only consists of four planets – Jupiter, Saturn, Mercury and Venus. A horoscope like this should have a great number of solutions, which makes it relatively easy to choose the desired one out of their number. And yet Venus turned out to be invisible in the solution desired by the historians, despite the explicit indications of the contrary contained in the Sumerian tablet. Furthermore, the tablet contains a more precise stipulation concerning the mutual disposition of the Moon and the Delta of Capricorn, which also fails to fit the Scaligerian dating as suggested by the historians.

In general, the work ([1017:0]) makes it perfectly clear that any kind of "confirmation" that the Scaligerian datings allegedly get from the astronomical dating of Sumerian tablets is right out of the question.

It appears that Sumerian tablets still await an independent astronomical dating – should it prove possible at all, due to the vagueness of the astronomical indications pertinent to these tablets. According to the translations of tablets given in [1070:0], almost all of the Sumerian astronomical indications are very dubious and imprecise.

One could also enquire about just how well the modern translators of Sumerian tables understand the meaning of the astronomical terms used by the "ancient" Sumerians. It is possible that astronomical meaning of Sumerian texts is much different from whatever the opinion of modern specialists implies.

5. A LIST OF 28 ANCIENT ZODIACS, DISCOVERED AND DATED BY THE AUTHORS RECENTLY

Our study of sources and ancient artwork of all sorts made it possible for us to discover a large enough number of ancient zodiacs. We have managed to date many of them. Let us list a total of 28 ancient zodiacs, Egyptian as well as European, that the authors of the present book managed to date (see fig. 19.2). A detailed description of the datings was provided in a number of our other works, such as "New Chronology of Egypt" (2002, 2004), "Ancient Zodiacs of Egypt and Europe" (2005), "The Baptism of Russia" (2006) and "Regal Rome between the Oka and the Volga" (2007). We shall simply cite our end results presently. All the post-1582 dates in the list that follows were rendered to the Julian Calendar ("old style", that is).

1. Zodiac of Pharaoh Seti I (SP), Egypt: 969 A.D. (14-16 August) or 1206 A.D. (5-7 August).
2. The Stele of Metternich (MT), Egypt: 1007 A.D. (14-16 August).
3. The "Mitre" of Apulum, Europe: 1007 A.D. (14-16 August).
4. The "Mitre" of Heddernheim, Europe: 1007 A.D. (14-15 October) or 1186 A.D. (14-15 October).
5. The Zodiac of Senenmut (SN), Egypt: 1007 A.D. (14-16 June).
6. The Brief Zodiac (KZ), Egypt: 1071 A.D. (15-16 May), 1189 A.D. (30-31 May), or, alternatively, 1308 A.D. (6-8 May).
7. Zodiac of Pharaoh Ramses IV (RC), Egypt: 1146 A.D. (15-16 April) or 1325 A.D. (16 April).

8. The Second Zodiac of Senenmut (SO), Egypt: 1148 A.D. (17-18 June).

9. The Golden Horn of Copenhagen, Europe: 1166 A.D. (17-28 May).

10. The Long Zodiac of Dendera (DL), Egypt, 1168 A.D. (22-26 April).

11. Zodiac of Pharaoh Ramses VII – "Coloured Zodiac of Thebes", that is. Luxor Valley of the Kings (OU), Egypt: 1182 A.D. (5-8 September).

12. The Round Zodiac of Dendera (DR), Egypt: 1185 A.D. (morning, 20 March).

13. The "Lion of Commagena" zodiac (LK), Turkey: 1221 A.D. (morning, 14 September).

14. Zodiac from the Tomb of Petosiris, external chamber (P1), Egypt: 1227 (5 August) or 1667 (2 August, old style).

15. The Upper Athribean Zodiac of Flinders Petrie (AV), Egypt: 1230 A.D. (15-16 May).

16. Zodiac from the Tomb of Petosiris, internal chamber (P2), Egypt: 1240 A.D. (24-25 March) or 1714 A.D. (2 April, old style).

17. The Lower Athribean Zodiac of Flinders Petrie (AV), Egypt: 1268 A.D. (9-10 February).

18. The "Clad Nuit" zodiac (NB), Egypt: 1285 A.D. (31 January – 1 February) or 1345 A.D. (29-31 January).

19. Zodiac of Pharaoh Ramses VI (RS), Egypt: 1289 A.D. (4-5 February) or 1586 A.D. (20-21 February, old style).

20. Zodiac from the Greater Temple of Esna (EB), Egypt: 1394 (31 March – 3 April).

21. Zodiac from the Lesser Temple of Esna (EM), Egypt: 1404 (6-8 May).

22. The Carpet of Baillet, Europe: 1495 (15 March).

23. The Italian Zodiac by Justo of Padua (PZ), Europe: 1524 A.D. (7 March).

24. The Louvre Zodiac (LV), Europe: 1638 A.D. (12-17 June, old style).

25. The gemma of "Marcus Aurelius" (RZ), Europe: 1664 A.D. (8-9 December, old style).

26. Brugsch's zodiac, known as the "demotic subscript zodiac" (BR1), Egypt: 1682 A.D. (17 November, old style) or 1861 A.D. (18 November, new style).

27. Brugsch's zodiac, known as "the horoscope with no rods" (BR2), Egypt: 1841 A.D. (6-7 October, old style).

28. Brugsch's zodiac, known as "the horoscope in boats" (BR3), Egypt: 1853 A.D. (15 February, old style).

Annexes

Tables of fast and named stars of the Almagest that can be identified reliably

In the present annex we cite the following tables: P1.1, P1.2, P1.3 and Table 4.4. These tables were described in Chapter 1 (Section 4) and Chapter 4 (Section 3) of the present book, but not cited therein due to the greatness of their volume.

The table of the fast stars contained in the Almagest (Table P1.1) is comprised of the stars whose annual proper motion velocity by one of the coordinates equals 0.1" at least.

The tables of the Almagest's named stars (P1.2 and P1.3) contains the Almagest stars that had names of their own in mediaeval astronomy.

A detailed description of Table 4.4 can be found in Section 3 of Chapter 4. It contains the fast stars visible to the naked eye and reliably identified in the Almagest.

Explanatory notes for Table P1.1

Table P1.1 uses stellar coordinates given in the equatorial system for the epoch of the beginning of the year 1900. The proper movement speeds are rendered to the equator.

The data from table P1.1 are taken from the Bright Star Catalogue BS5 (as found online in its electronic version). All of the online coordinates were verified by the printed version of the same catalogue in its previous printed version (BS4, [1197]). All the misprints found in the electronic version were corrected.

Table P1.1 contains a list of the stars that was referred to as the "fast" star list in Chapter 1. It consists of the modern stars that can be seen by the naked eye and possess a great enough rate of shifting due to high proper speeds, identified as Almagest stars in the modern catalogues – presumably contained in the Almagest. More specifically, in the compilation of the present list we have chosen all of the stars from the Bright Star Catalogue BS5 satisfying to the following criteria:

1) The proper motion velocity of the star in question by one of the equatorial system's coordinates for the epoch of 1900 isn't any lower than 0.1" per year as rendered to the equator.

2) The modern indication of the star should contain Bayer's Greek letter or Flamsteed's number.

These criteria were applied in order to reject the stars that were a priori useless for the dating of the Almagest, qv in Chapter 1.

Symbol "i." in Table P1.1 marks the identifications in the online version of the Almagest based on the Manitius edition of the Almagest (K. Manitius, ed. B. G. Teubner, Leipzig 1913). Symbol "P." marks the

(continued on page 664)

Table P1.1 (a)

Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]	*Modern indication of the star*	*Number of the star in the Almagest (Bailey's enumeration)*	*Coordinates in the Almagest*				*Brightness in the Almagest*	*D?*
			longitude		*latitude*			
			°	′	°	′		
15	21AlpAnd	315	347	50	+26	00	2–3	
21	11BetCas	189	7	50	+51	40	3	
33	6Cet	672	329	40	–14	40	4–3	
163	30EpsAnd	337	354	20	+23	00	4	
165	31DelAnd	335	355	20	+24	30	3	
188	16BetCet	733	335	40	–20	20	3	
194*i.	17Phi1Cet	731	339	00	–14	00	5–4	D
194P.	17Phi1Cet	730	339	20	–13	00	5–4	
215	34ZetAnd	344	354	10	+17	30	4	
219	24EtaCas	180	13	00	+47	50	4	
235*i.	19Phi2Cet	730	339	20	–13	00	5–4	D
235P.	19Phi2Cet	728	341	00	–13	40	5	
269	37MuAnd	347	1	50	+30	00	4	
321i.	30MuCas	185	14	40	+44	20	4	D
330	80Psc	687	352	20	–2	00	6	
334	31EtaCet	727	345	00	–15	40	3	
337	43BetAnd	346	3	50	+26	20	3	
343P.	33TheCas	185	14	40	+44	20	4	
343i.	33TheCas	186	17	40	+45	00	5	D
361/2	86ZetPsc	686	353	00	–0	10	4	
402i.	45TheCet	726	349	40	–15	40	3	
402P.	45TheCet	726	349	40	–15	20	3	
403	37DelCas	182	20	40	+45	30	3	
417i.	48OmeAnd	356	14	10	+32	30	5	D
434	98MuPsc	689	356	30	–2	20	4	
458	50UpsAnd	352	12	20	+29	00	4	
464	51And	351	15	10	+35	40	4–3	
509	52TauCet	723	352	00	–25	20	3	
544	2AlpTri	358	11	00	+16	30	3	
545	5Gam1Ari	362	6	40	+7	20	3–4	
553	6BetAri	363	7	40	+8	20	3	
585	59UpsCet	724	353	00	–30	50	4	
617i.	13AlpAri	375	10	40	+10	30	3–2	
617P.	13AlpAri	375	10	40	+10	00	3–2	
622	4BetTri	359	16	00	+20	40	3	
646	17EtaAri	364	11	00	+7	40	5	
660	8DelTri	360	16	20	+19	40	4	

Table P1.1 (b)

Number of the star in the Bright Star Catalogue	*Upright ascent RA(1900) in BS5*			*Inclination D(1900) in BS5*			*Value in BS5*	*Proper movement speed in BS4 (" / year × 1000)*	
	h	m	s	°	′	″		$V_{RA(1900)}$	$V_{D(1900)}$
15	00	03	13.0	+28	32	18	2.06	+0.137	–0.158
21	00	03	50.2	+58	35	54	2.27	+0.526	–0.177
33	00	06	10.5	–16	01	01	4.89	–0.081	–0.264
163	00	33	16.1	+28	46	08	4.37	–0.228	–0.249
165	00	33	58.7	+30	18	50	3.27	+0.137	–0.084
188	00	38	34.2	–18	32	08	2.04	+0.232	+0.036
194	00	39	08.7	–11	09	15	4.76	–0.013	–0.108
194	00	39	08.7	–11	09	15	4.76	–0.013	–0.108
215	00	42	02.1	+23	43	24	4.06	–0.100	–0.078
219	00	43	03.0	+57	17	06	3.44	+1.101	–0.521
235	00	45	07.1	–11	10	58	5.19	–0.230	–0.223
235	00	45	07.1	–11	10	58	5.19	–0.230	–0.223
269	00	51	12.0	+37	57	25	3.87	+0.152	+0.037
321	01	01	36.8	+54	25	47	5.17	+3.423	–1.575
330	01	03	13.0	+05	07	15	5.52	–0.264	–0.175
334	01	03	33.5	–10	42	44	3.45	+0.214	–0.133
337	01	04	07.8	+35	05	26	2.06	+0.179	–0.109
343	01	05	00.5	+54	37	05	4.33	+0.229	–0.017
343	01	05	00.5	+54	37	05	4.33	+0.229	–0.017
361/2	01	08	30.3	+07	02	48	5.24	+0.141	–0.050
402	01	19	01.5	–08	41	58	3.60	–0.083	–0.218
402	01	19	01.5	–08	41	58	3.60	–0.083	–0.218
403	01	19	16.1	+59	42	56	2.68	+0.300	–0.045
417	01	21	40.1	+44	53	26	4.83	+0.347	–0.100
434	01	24	56.6	+05	37	42	4.84	+0.294	–0.042
458	01	30	55.5	+40	54	19	4.09	–0.173	–0.379
464	01	31	51.0	+48	07	18	3.57	+0.066	–0.108
509	01	39	25.3	–16	27	51	3.50	–1.720	+0.858
544	01	47	22.7	+29	05	30	3.41	+0.010	–0.229
545	01	48	02.4	+18	48	21	4.83	+0.078	–0.108
553	01	49	06.8	+20	19	09	2.64	+0.097	–0.108
585	01	55	17.6	–21	33	44	4.00	+0.131	–0.020
617	02	01	32.0	+22	59	23	2.00	+0.190	–0.144
617	02	01	32.0	+22	59	23	2.00	+0.190	–0.144
622	02	03	35.4	+34	30	52	3.00	+0.148	–0.037
646	02	07	12.0	+20	44	28	5.27	+0.161	+0.007
660	02	10	56.8	+33	46	00	4.87	+1.154	–0.237

Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]	Modern indication of the star	Number of the star in the Almagest (Bailey's enumeration)	Coordinates in the Almagest				Brightness in the Almagest	D?
			longitude		latitude			
			°	′	°	′		
740	76SigCet	720	3	20	–28	00	4	
781	83EpsCet	721	6	40	–25	10	4	
799	13ThePer	194	27	30	+32	20	4	
804	86GamCet	714	12	40	–11	30	3	
812*i.	38Ari	374	15	00	–5	15	4–3	
813i.	87MuCet	717	12	40	–6	20	4	D
818	1Tau1Eri	789	5	10	–32	10	4	
824	39Ari	377	21	20	+12	40	5	
838	41Ari	376	21	40	+10	10	4	
840	16Per	219	24	40	+20	40	7	
869i.	46Rho3Ari	372	19	40	+1	30	5	
869*P.	46Rho3Ari	372	19	40	+1	10	5	
874i.	3EtaEri	788	10	30	–23	15	4	D
874P.	3EtaEri	787	12	10	–23	50	3	
919	11Tau3Eri	791	8	50	–38	30	4	
921	25RhoPer	204	27	40	+21	00	4	
937	IotPer	196	31	30	+31	10	4	
941	27KapPer	201	30	30	+27	00	4	
951	57DelAri	369	23	50	+1	40	4	
1084	18EpsEri	784	22	00	–28	00	3	
1101	10Tau	413	25	00	–17	30	4	
1136	23DelEri	783	24	10	–28	50	3	
1173	27Tau6Eri	794	21	20	–41	20	4	
1210i.	43Per	218	45	00	+31	00	5	
1231	34GamEri	781	27	00	–32	50	3	
1325	40Omi2Eri	779	35	30	–27	00	4	
1346	54GamTau	390	39	00	–5	45	3–4	
1373	61Del1Tau	391	40	20	–4	15	3–4	
1392	69UpsTau	401	42	00	+0	30	5	
1409	74EpsTau	394	41	50	–3	00	3–4	
1411	77The1Tau	392	40	50	–5	50	3–4	
1453*	50Ups1Eri	798	34	10	–50	20	4	
1457	87AlpTau	393	42	40	–5	10	1	
1473	90Tau	388	42	10	–10	00	4	
1543	1Pi3Ori	755	44	50	–15	50	3	D
1656	104Tau	396	50	20	–5	00	5	
1708	13AlpAur	222	55	00	+22	30	1	
1791	112BetTau	400	55	40	+5	00	3	

Number of the star in the Bright Star Catalogue	*Upright ascent RA(1900) in BS5*			*Inclination D(1900) in BS5*			*Value in BS5*	*Proper movement speed in BS4 (" / year × 1000)*	
	h	m	s	°	′	″		$V_{RA(1900)}$	$V_{D(1900)}$
740	02	27	20.8	–15	41	01	4.75	–0.077	–0.117
781	02	34	43.6	–12	17	48	4.84	+0.141	–0.234
799	02	37	21.9	+48	48	20	4.12	+0.336	–0.083
804	02	38	07.1	+02	48	52	3.47	–0.145	–0.148
812	02	39	30.5	+12	01	30	5.18	+0.120	–0.080
813	02	39	32.1	+09	41	31	4.27	+0.281	–0.030
818	02	40	26.1	–18	59	45	4.47	+0.325	+0.042
824	02	41	57.1	+28	49	55	4.51	+0.150	–0.119
838	02	44	05.7	+26	50	54	3.63	+0.067	–0.112
840	02	44	16.0	+37	54	25	4.23	+0.189	–0.104
869	02	50	47.3	+17	37	28	5.63	+0.276	–0.207
869	02	50	47.3	+17	37	28	5.63	+0.276	–0.207
874	02	51	32.5	–09	17	46	3.89	+0.074	–0.217
874	02	51	32.5	–09	17	46	3.89	+0.074	–0.217
919	02	57	58.9	–24	00	59	4.09	–0.147	–0.051
921	02	58	45.9	+38	27	10	3.39	+0.130	–0.102
937	03	01	50.8	+49	13	53	4.05	+1.264	–0.078
941	03	02	44.8	+44	28	43	3.80	+0.178	–0.153
951	03	05	54.5	+19	20	55	4.35	+0.151	–0.007
1084	03	28	13.1	–09	47	48	3.73	–0.979	+0.019
1101	03	31	46.1	+00	05	04	4.28	–0.235	–0.481
1136	03	38	27.4	–10	06	06	3.54	–0.099	+0.746
1173	03	42	32.7	–23	32	42	4.23	–0.162	–0.527
1210	03	49	10.1	+50	24	21	5.28	+0.092	–0.127
1231	03	53	21.8	–13	47	34	2.95	+0.057	–0.110
1325	04	10	40.2	–07	48	30	4.43	–2.231	–3.420
1346	04	14	06.0	+15	23	11	3.65	+0.116	–0.024
1373	04	17	09.9	+17	18	29	3.76	+0.107	–0.028
1392	04	20	19.3	+22	35	13	4.28	+0.105	–0.045
1409	04	22	46.5	+18	57	31	3.53	+0.108	–0.036
1411	04	22	51.6	+15	44	25	3.84	+0.102	–0.026
1453	04	29	35.1	–29	58	07	4.51	–0.105	–0.274
1457	04	30	10.9	+16	18	30	0.85	+0.065	–0.189
1473	04	32	34.0	+12	18	37	4.27	+0.098	–0.010
1543	04	44	24.6	+06	47	12	3.19	+0.463	+0.017
1656	05	01	32.3	+18	30	39	5.00	+0.537	+0.019
1708	05	09	18.0	+45	53	47	0.08	+0.080	–0.423
1791	05	19	58.1	+28	31	23	1.65	+0.025	–0.175

Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]	*Modern indication of the star*	*Number of the star in the Almagest (Bailey's enumeration)*	*Coordinates in the Almagest*				*Brightness in the Almagest*	*D?*
			longitude		*latitude*			
			°	′	°	′		
1983	13GamLep	815	59	00	–45	50	4–3	
2035	15DelLep	814	61	00	–44	10	4–3	
2040	BetCol	844	59	00	–59	40	2	
2047	54Chi1Ori	744	61	40	–3	45	5	
2077	33DelAur	220	62	30	+30	00	4	
2085	16EtaLep	817	62	40	–38	10	4–3	
2134	1Gem	442	64	10	–0	40	4	
2219	44KapAur	443	66	30	+5	50	4–3	
2286i.	13MuGem	438	68	30	–1	15	4–3	
2286P.	13MuGem	438	68	10	–1	15	4–3	
2326	AlpCar	892	77	10	–75	00	1	
2451	NuPup	891	80	10	–65	40	3–2	
2484	31XiGem	441	74	40	–10	30	4	
2491	9AlpCMa	818	77	40	–39	10	1	
2574	14TheCMa	819	79	40	–35	00	4	
2821	60IotGem	428	82	00	+5	30	4	
2846*i.	63Gem	432	83	10	+0	20	5	D
2878	SigPup	881	101	10	–63	00	4	D
2890/1i.	66AlpGem	424	83	20	+9	30	2	
2890/1P.	66AlpGem	424	83	20	+9	40	2	
2905	69UpsGem	429	84	00	+4	50	4	
2943	10AlpCMi	848	89	10	–16	10	1	
2990	78BetGem	425	86	40	+6	15	2	
3208/9i.	16Zet1Cnc	448	93	00	–2	40	4	
3208/9P.	16Zet1Cnc	448	95	40	–2	40	4	
3208/9T.	16Zet1Cnc	448	90	40	–2	40	4	
3323	1OmiUMa	9	85	20	+39	50	4	
3449	43GamCnc	452	100	20	+2	40	4–3	
3461	47DelCnc	453	101	20	–0	10	4–3	
3482	11EpsHya	896	105	20	–11	30	4	
3518	GamPyx	877	118	00	–43	20	4	
3556	DelPyx	878	119	00	–43	30	4	
3569	9IotUMa	20	95	30	+29	20	3	
3619	15UMa	23	95	50	+33	00	4	
3665	22TheHya	900	113	20	–13	40	4	
3690	38Lyn	39	103	20	+19	10	4	
3705	40AlpLyn	38	105	00	+17	15	4	
3757	23UMa	16	92	30	+44	20	4	

Number of the star in the Bright Star Catalogue	Upright ascent RA(1900) in BS5			Inclination D(1900) in BS5			Value in BS5	Proper movement speed in BS4 (" / year × 1000)	
	h	m	s	°	′	″		$V_{RA(1900)}$	$V_{D(1900)}$
1983	05	40	17.6	–22	28	51	3.60	–0.294	–0.373
2035	05	47	01.2	–20	53	15	3.81	+0.224	–0.650
2040	05	47	26.0	–35	48	21	3.12	+0.050	+0.402
2047	05	48	27.6	+20	15	28	4.41	–0.187	–0.086
2077	05	51	17.5	+54	16	37	3.72	+0.083	–0.126
2085	05	51	51.0	–14	11	09	3.71	–0.049	+0.136
2134	05	58	02.4	+23	16	08	4.16	–0.006	–0.102
2219	06	09	00.3	+29	32	06	4.35	–0.070	–0.265
2286	06	16	54.6	+22	33	54	2.88	+0.055	–0.112
2286	06	16	54.6	+22	33	54	2.88	+0.055	–0.112
2326	06	21	43.9	–52	38	27	–0.72	+0.026	+0.022
2451	06	34	42.0	–43	06	29	3.17	–0.007	–0.005
2484	06	39	40.6	+13	00	13	3.36	–0.115	–0.194
2491	06	40	44.6	–16	34	44	–1.46	–0.545	–1.211
2574	06	49	32.6	–11	54	48	4.07	–0.144	–0.017
2821	07	19	30.9	+27	59	49	3.79	–0.121	–0.088
2846	07	21	48.2	+21	38	59	5.22	–0.056	–0.124
2878	07	26	03.4	–43	05	56	3.25	–0.059	+0.186
2890/1	07	28	13.0	+32	06	27	1.98	–0.170	–0.102
2890/1	07	28	13.0	+32	06	27	1.98	–0.170	–0.102
2905	07	29	45.6	+27	07	05	4.06	–0.033	–0.109
2943	07	34	04.0	+05	28	53	0.38	–0.706	–1.029
2990	07	39	11.8	+28	16	04	1.14	–0.627	–0.051
3208/9	08	06	28.6	+17	56	58	5.63	+0.067	–0.139
3208/9	08	06	28.6	+17	56	58	5.63	+0.067	–0.139
3208/9	08	06	28.6	+17	56	58	5.63	+0.067	–0.139
3323	08	21	57.5	+61	03	09	3.36	–0.131	–0.110
3449	08	37	29.9	+21	49	42	4.66	–0.103	–0.043
3461	08	39	00.1	+18	31	19	3.94	–0.017	–0.233
3482	08	41	28.8	+06	47	09	3.38	–0.191	–0.055
3518	08	46	17.2	–27	20	20	4.01	–0.133	+0.082
3556	08	51	14.1	–27	17	49	4.89	+0.076	–0.105
3569	08	52	21.8	+48	26	04	3.14	–0.443	–0.235
3619	09	01	49.1	+52	00	30	4.48	–0.136	–0.039
3665	09	09	09.7	+02	44	11	3.88	+0.129	–0.313
3690	09	12	37.3	+37	13	33	3.82	–0.030	–0.127
3705	09	14	57.8	+34	48	56	3.13	–0.223	+0.013
3757	09	23	38.9	+63	29	57	3.67	+0.109	+0.026

Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]	*Modern indication of the star*	*Number of the star in the Almagest (Bailey's enumeration)*	*Coordinates in the Almagest*				*Brightness in the Almagest*	*D?*
			longitude		*latitude*			
			°	′	°	′		
3759	31Tau1Hya	903	118	30	–17	10	4	
3769*i.	8LMi	41	102	10	+22	30	7	
3775	25TheUMa	19	100	40	+35	00	3	
3786	PsiVel	880	137	30	–51	15	2–3	
3815i.	11LMi	40	106	10	+20	00	7	
3852	14OmiLeo	474	117	20	–4	10	4	
3888	29UpsUMa	17	99	00	+42	00	4	
3905	24MuLeo	464	114	20	+12	00	3	
3982	32AlpLeo	469	122	30	+0	10	1	
3994*i.	41LamHya	908	131	10	–23	15	4	
4033	33LamUMa	28	112	40	+29	20	3	
4057	41Gam1Leo	467	122	10	+8	30	2	
4094	42MuHya	909	138	00	–24	40	3	
4192	41LMi	489	126	00	+13	20	5	
4209	52Leo	478	130	20	+5	20	6	
4287	7AlpCrt	921	146	20	–23	00	4	
4301	50AlpUMa	24	107	40	+49	00	2	
4310	63ChiLeo	491	137	30	+1	10	4–5	
4314	Chi1Hya	913	152	20	–30	10	4	
4357	68DelLeo	481	134	10	+13	40	2–3	
4374/5	53XiUMa	32	130	20	+25	00	3	
4374/5	53XiUMa	32						
4382	12DelCrt	923	150	00	–18	00	4	
4399	78IotLeo	484	140	20	+5	50	3	
4450	XiHya	914	162	10	–31	20	4	
4517i.	3NuVir	497	146	20	+4	15	5	
4517P.	3NuVir	497	147	00	+4	15	5	
4534	94BetLeo	488	144	30	+11	50	1.3	
4540i.	5BetVir	501	149	00	+0	20	3	
4540P.	5BetVir	501	149	00	+0	10	3	
4608	9OmiVir	499	150	40	+8	00	5	
4626*i.	10Vir	930	166	40	–18	10	5	
4660	69DelUMa	26	123	10	+51	00	3	
4662i.	4GamCrv	931	163	20	–14	50	3	
4662P.+T.	4GamCrv	931	163	30	–14	50	3	
4757	7DelCrv	932	166	40	–12	30	3	
4775i.	8EtaCrv	933	167	00	–11	40	4	
4775P.+T.	8EtaCrv	933	167	00	–11	45	4	

Number of the star in the Bright Star Catalogue	Upright ascent RA(1900) in BS5			Inclination D(1900) in BS5			Value in BS5	Proper movement speed in BS4 (" / year × 1000)	
	h	m	s	°	′	″		$V_{RA(1900)}$	$V_{D(1900)}$
3759	09	24	04.3	–02	19	55	4.60	+0.126	–0.018
3769	09	25	27.3	+35	32	44	5.37	–0.056	–0.107
3775	09	26	10.3	+52	08	00	3.17	–0.952	–0.540
3786	09	26	45.6	–40	01	44	3.60	–0.189	+0.069
3815	09	29	39.7	+36	15	45	5.41	–0.706	–0.248
3852	09	35	48.8	+10	20	50	3.52	–0.143	–0.041
3888	09	43	52.9	+59	30	33	3.80	–0.293	–0.156
3905	09	47	04.6	+26	28	41	3.88	–0.215	–0.060
3982	10	03	02.8	+12	27	22	1.35	–0.249	+0.003
3994	10	05	42.7	–11	51	35	3.61	–0.207	–0.095
4033	10	11	04.0	+43	24	50	3.45	–0.165	–0.043
4057	10	14	27.6	+20	20	51	2.61	+0.307	–0.151
4094	10	21	15.2	–16	19	33	3.81	–0.132	–0.083
4192	10	37	58.7	+23	42	43	5.08	–0.117	+0.004
4209	10	41	07.5	+14	43	22	5.48	–0.126	–0.069
4287	10	54	54.1	–17	45	58	4.08	–0.465	+0.124
4301	10	57	33.6	+62	17	27	1.79	–0.118	–0.071
4310	10	59	51.5	+07	52	36	4.63	–0.342	–0.050
4314	11	00	30.7	–26	45	14	4.94	–0.190	–0.005
4357	11	08	47.4	+21	04	18	2.56	+0.143	–0.135
4374/5	11	12	50.9	+32	05	31	4.87	–0.432	–0.591
4374/5	11	12	50.9	+32	05	31	4.41	–0.432	–0.591
4382	11	14	20.4	–14	14	14	3.56	–0.128	+0.201
4399	11	18	42.7	+11	04	49	3.94	+0.166	–0.079
4450	11	28	04.9	–31	18	15	3.54	–0.207	–0.042
4517	11	40	43.1	+07	05	23	4.03	–0.021	–0.187
4517	11	40	43.1	+07	05	23	4.03	–0.021	–0.187
4534	11	43	57.5	+15	07	52	2.14	–0.497	–0.119
4540	11	45	29.1	+02	19	42	3.61	+0.741	–0.275
4540	11	45	29.1	+02	19	42	3.61	+0.741	–0.275
4608	12	00	06.9	+09	17	18	4.12	–0.221	+0.043
4626	12	04	33.8	+02	27	34	5.95	+0.042	–0.183
4660	12	10	28.7	+57	35	18	3.31	+0.102	+0.004
4662	12	10	39.7	–16	59	12	2.59	–0.163	+0.018
4662	12	10	39.7	–16	59	12	2.59	–0.163	+0.018
4757	12	24	41.3	–15	57	31	2.95	–0.213	–0.143
4775	12	26	54.9	–15	38	32	4.31	–0.430	–0.066
4775	12	26	54.9	–15	38	32	4.31	–0.430	–0.066

Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]	*Modern indication of the star*	*Number of the star in the Almagest (Bailey's enumeration)*	*Coordinates in the Almagest*				*Brightness in the Almagest*	*D?*
			longitude		*latitude*			
			°	′	°	′		
4785	8BetCVn	37	140	10	+41	20	5	
4819	GamCen	957	185	50	–40	00	3	
4825/6	29GamVir	503	163	10	+2	50	3	
4847	32Vir	508	160	10	+11	40	6	D
4905	77EpsUMa	33	132	10	+53	30	2	
4914	12Alp1CVn	36	147	50	+39	45	3	
4932i.	47EpsVir	509	162	10	+15	10	3–2	
4932P.	47EpsVir	509	162	10	+16	00	3–2	
4981i.	53Vir	526	177	10	–7	10	6	
4981P.	53Vir	526	177	10	–7	20	6	
5028	IotCen	939	186	10	–25	40	3	
5054/5	79ZetUMa	34	138	00	+55	40	2	
5054/5	79ZetUMa	34						
5056	67AlpVir	510	176	40	–2	00	1	
5064	68Vir	515	178	00	–3	00	5	D
5095	74Vir	512	176	20	+3	20	5	
5107	79ZetVir	511	174	50	+8	40	3	
5168	1Cen	937	189	10	–20	30	4–3	
5185	4TauBoo	108	170	30	+26	30	4	
5191	85EtaUMa	35	149	50	+54	00	2	
5196	89Vir	528	185	00	–7	50	6	
5235	8EtaBoo	107	171	20	+28	00	3	
5267	BetCen	970	204	10	–45	20	2	
5315	98KapVir	519	187	20	+2	40	4	
5338i.	99IotVir	518	186	40	+7	10	4	
5338P.	99IotVir	518	186	40	+7	30	4	
5340	16AlpBoo	110	177	00	+31	30	1	
5350	21IotBoo	89	154	10	+58	20	5	
5351	19LamBoo	91	159	40	+54	40	5	
5404	23TheBoo	90	155	20	+60	10	5	
5409	105PhiVir	520	188	20	+11	40	4	
5429	25RhoBoo	105	175	00	+42	10	4–3	
5435	27GamBoo	92	169	40	+49	00	3	
5447	28SigBoo	104	175	40	+41	40	4	
5459/60i.	Alp1Cen	969	218	20	–41	10	1	
5459/60	Alp2Cen	969	218	20	–41	10	1	
5459/60P.	Alp1Cen	969	218	20	–44	10	1	
5487	107MuVir	522	192	40	+9	50	4	

Number of the star in the Bright Star Catalogue	Upright ascent RA(1900) in BS5			Inclination D(1900) in BS5			Value in BS5	Proper movement speed in BS4 (" / year × 1000)	
	h	m	s	°	′	″		$V_{RA(1900)}$	$V_{D(1900)}$
4785	12	28	59.6	+41	54	03	4.26	–0.707	+0.288
4819	12	35	59.9	–48	24	38	2.17	–0.190	–0.008
4825/6	12	36	35.5	–00	54	03	3.68	–0.568	+0.008
4847	12	40	33.9	+08	13	13	5.22	–0.110	+0.000
4905	12	49	37.8	+56	30	09	1.77	+0.109	–0.010
4914	12	51	19.7	+38	51	17	5.60	–0.238	+0.057
4932	12	57	11.9	+11	29	48	2.83	–0.275	+0.017
4932	12	57	11.9	+11	29	48	2.83	–0.275	+0.017
4981	13	06	44.1	–15	39	33	5.04	+0.094	–0.292
4981	13	06	44.1	–15	39	33	5.04	+0.094	–0.292
5028	13	14	58.4	–36	11	05	2.75	–0.340	–0.089
5054/5	13	19	54.0	+55	26	51	2.27	+0.119	–0.025
5054/5	13	19	54.9	+55	26	39	3.95	+0.115	–0.033
5056	13	19	55.4	–10	38	22	0.98	–0.043	–0.033
5064	13	21	26.1	–12	11	14	5.25	–0.135	–0.025
5095	13	26	45.9	–05	44	22	4.69	–0.103	–0.047
5107	13	29	35.8	–00	05	05	3.37	–0.286	+0.036
5168	13	40	00.2	–32	32	17	4.23	–0.462	–0.150
5185	13	42	30.6	+17	57	19	4.50	–0.482	+0.034
5191	13	43	36.0	+49	48	45	1.86	–0.124	–0.014
5196	13	44	26.1	–17	38	10	4.97	–0.102	–0.041
5235	13	49	55.3	+18	53	56	2.68	–0.064	–0.363
5267	13	56	45.8	–59	53	26	0.61	–0.020	–0.023
5315	14	07	33.6	–09	48	30	4.19	+0.006	+0.136
5338	14	10	46.1	–05	31	24	4.08	–0.009	–0.432
5338	14	10	46.1	–05	31	24	4.08	–0.009	–0.432
5340	14	11	06.0	+19	42	11	–0.04	–1.098	–1.999
5350	14	12	37.4	+51	49	42	4.75	–0.154	+0.088
5351	14	12	34.9	+46	32	51	4.18	–0.190	+0.158
5404	14	21	47.5	+52	18	47	4.05	–0.242	–0.400
5409	14	23	02.9	–01	46	47	4.81	–0.141	–0.005
5429	14	27	31.2	+30	48	37	3.58	–0.102	+0.117
5435	14	28	03.0	+38	44	44	3.03	–0.116	+0.149
5447	14	30	19.5	+30	10	46	4.46	+0.188	+0.129
5459/60	14	32	48.3	–60	25	22	–0.01	–3.608	+0.712
5459/60	14	32	48.3	–60	25	22	1.33	–3.608	+0.712
5459/60	14	32	48.3	–60	25	22	–0.01	–3.608	+0.712
5487	14	37	47.3	–05	13	25	3.88	+0.105	–0.321

Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]	*Modern indication of the star*	*Number of the star in the Almagest (Bailey's enumeration)*	*Coordinates in the Almagest*				*Brightness in the Almagest*	*D?*
			longitude		*latitude*			
			°	′	°	′		
5531	9Alp2Lib	529	198	00	+0	40	2	
5634i.	45Boo	99	188	10	+41	20	5	D
5634P.	45Boo	99	188	10	+41	40	5	
5646i.	Kap1Lup	978	210	30	–29	00	5	D
5647i.	Kap2Lup	978	210	30	–29	00	5	D
5646/7i.	KapLup	978	210	40P.	–29	00	5	D
5646/7P.	KapLup	980	213	40	–30	10	5	
5649	ZetLup	981	215	40	–33	10	5	
5681	49DelBoo	94	185	40	+48	40	4–3	
5698i.	Nu1Lup	980	213	40	–30	10	5	D
5709	1OmiCrB	98	188	30	+45	30	5	
5733/4	51Mu1Boo	95	185	40	+53	15	4	
5733/4	51Mu2Boo	95						
5747	3BetCrB	112	191	40	+46	30	4–3	
5777	37Lib	537	206	10	+9	00	5	
5793	5AlpCrB	111	194	40	+44	30	2–1	
5838*i.	43KapLib	542	211	10	–1	30	4	
5838P.	43KapLib	541	210	20	+0	20	5	
5849	8GamCrB	115	197	10	+44	45	4	
5854	24AlpSer	271	204	20	+25	20	3	
5868	27LamSer	270	204	50	+26	30	4	
5892	37EpsSer	272	206	20	+24	00	3	
5908	46TheLib	536	213	00	+3	30	4–5	
5914	1ChiHer	146	191	10	+60	00	4	
5933	41GamSer	265	204	20	+36	00	3	
5986	13TheDra	69	160	20	+74	40	4–3	
6056	1DelOph	240	215	00	+17	00	3	
6116	21EtaUMi	5	93	40	+77	40	4	
6212i.	40ZetHer	129	213	50	+50	40	3	
6212P.	40ZetHer	129	213	50	+53	10	3	
6241	26EpsSco	557	228	30	–11	00	3	
6271*	Zet2Sco	559	230	00	–18	00	4	D
6299	27KapOph	238	224	40	+31	50	4	
6315	19Dra	66	159	20	+83	00	5	
6380	EtaSco	561	233	10	–19	30	3	
6401/2	36Oph	247	233	00	–2	15	4	
6401/2	36Oph	247	233	00	–2	15	4	
6410	65DelHer	123	226	40	+48	00	3	

Number of the star in the Bright Star Catalogue	Upright ascent RA(1900) in BS5			Inclination D(1900) in BS5			Value in BS5	Proper movement speed in BS4 (" / year × 1000)	
	h	m	s	°	′	″		$V_{RA(1900)}$	$V_{D(1900)}$
5531	14	45	20.7	–15	37	34	2.75	–0.108	–0.071
5634	15	02	54.5	+25	15	31	4.93	+0.185	–0.171
5634	15	02	54.5	+25	15	31	4.93	+0.185	–0.171
5646	15	04	58.8	–48	21	27	3.87	–0.096	–0.049
5647	15	05	00.4	–48	21	49	5.69	–0.102	–0.042
5646/7	15	04	58.8	–48	21	27	3.87	–0.096	–0.049
5646/7	15	04	58.8	–48	21	27	3.87	–0.096	–0.049
5649	15	05	05.8	–51	43	07	3.41	–0.107	–0.070
5681	15	11	28.2	+33	41	16	3.47	+0.083	–0.116
5698	15	15	10.1	–47	33	49	5.00	–0.136	–0.139
5709	15	16	00.2	+29	58	44	5.51	–0.122	–0.049
5733/4	15	20	42.7	+37	43	40	4.31	–0.147	+0.084
5733/4	15	20	44.1	+37	41	53	6.50	–0.148	+0.091
5747	15	23	42.3	+29	27	01	3.68	–0.179	+0.083
5777	15	28	42.6	–09	43	18	4.62	+0.303	–0.241
5793	15	30	27.2	+27	03	04	2.23	+0.120	–0.091
5838	15	36	11.0	–19	21	17	4.74	–0.038	–0.107
5838	15	36	11.0	–19	21	17	4.74	–0.038	–0.107
5849	15	38	32.5	+26	36	45	3.84	–0.106	+0.043
5854	15	39	20.5	+06	44	25	2.65	+0.136	+0.044
5868	15	41	35.3	+07	39	59	4.43	–0.225	–0.068
5892	15	45	49.8	+04	46	43	3.71	+0.126	+0.061
5908	15	48	07.8	–16	26	09	4.15	+0.098	+0.129
5914	15	49	13.0	+42	43	53	4.62	+0.437	+0.628
5933	15	51	50.0	+15	59	16	3.85	+0.306	–1.285
5986	16	00	00.8	+58	49	56	4.01	–0.325	+0.336
6056	16	09	06.2	–03	26	13	2.74	–0.048	–0.145
6116	16	20	25.2	+75	59	09	4.95	–0.085	+0.250
6212	16	37	30.9	+31	47	01	2.81	–0.471	+0.394
6212	16	37	30.9	+31	47	01	2.81	–0.471	+0.394
6241	16	43	41.1	–34	06	42	2.29	–0.610	–0.255
6271	16	47	32.7	–42	11	24	3.62	–0.125	–0.236
6299	16	52	56.0	+09	31	49	3.20	–0.294	–0.010
6315	16	55	28.6	+65	17	15	4.89	+0.233	+0.046
6380	17	04	59.3	–43	06	26	3.33	+0.023	–0.285
6401/2	17	09	11.7	–26	27	21	5.11	–0.463	–1.141
6401/2	17	09	11.8	–26	27	17	5.07	–0.495	–1.132
6410	17	10	55.4	+24	57	25	3.14	–0.023	–0.157

Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]	*Modern indication of the star*	*Number of the star in the Almagest (Bailey's enumeration)*	*Coordinates in the Almagest*				*Brightness in the Almagest*	*D?*
			longitude		*latitude*			
			°	′	°	′		
6445	40XiOph	246	233	40	+2	15	4–3	
6486	44Oph	249	235	00	–0	20	4	
6554/5	24Nu1Dra	45	221	50	+78	30	4–3	
6554/5	25Nu2Dra	45						
6556	55AlpOph	234	234	50	+36	00	3–2	
6566	27Dra	63	118	40	+87	30	6	
6596	28OmeDra	64	111	40	+86	50	6	
6603	60BetOph	235	238	00	+27	15	4–3	
6623	86MuHer	125	237	40	+52	00	4–3	
6636/7	31Psi1Dra	60	73	20	+84	30	4	
6636/7	31Psi1Dra	60	73	20	+84	30	4	
6698	64NuOph	243	242	20	+13	40	4–5	
6710	57ZetSer	278	243	40	+20	00	4	
6746i.	10Gam2Sgr	570	244	30	–6	30	3	
6746P.	10Gam2Sgr	570	244	30	–6	20	3	
6752	70Oph	261	243	40	+27	00	4	
6832	EtaSgr	594	246	40	–13	00	3	
6869	58EtaSer	279	248	40	+21	10	4–3	
6879	20EpsSgr	572	248	00	–10	50	3	
6913	22LamSgr	573	249	00	–1	30	3	
6927i.	44ChiDra	61	50	20	+87	30	4	
6927P.	44ChiDra	61	50	20	+83	30	4	
7001	3AlpLyr	149	257	20	+62	00	1	
7152	EpsCrA	1006	255	10	–15	20	6	
7226/7	GamCrA	1005	256	30	–15	10	4	
7226/7	GamCrA	1005	256	30	–15	10	4	
7234	40TauSgr	590	257	40	–4	30	4–3	
7328	1KapCyg	167	286	40	+74	00	4–3	
7348	AlpSgr	593	257	00	–18	00	2–3	D
7352	60TauDra	59	26	10	+80	15	5	
7377	30DelAql	297	266	00	+25	00	4–3	
7420	10Iot2Cyg	166	291	10	+71	30	4–3	
7469	13TheCyg	165	292	30	+69	40	4	
7557	53AlpAql	288	273	50	+29	10	2–1	
7560i.	54OmiAql	289	274	40	+30	00	3–4	D
7597	58OmeSgr	597	267	40	–4	50	5	
7602	60BetAql	287	274	50	+27	10	3	
7715i.	2Xi2Cap	604	275	00	+8	00	6	

Number of the star in the Bright Star Catalogue	Upright ascent RA(1900) in BS5			Inclination D(1900) in BS5			Value in BS5	Proper movement speed in BS4 (" / year × 1000)	
	h	m	s	°	′	″		$V_{RA(1900)}$	$V_{D(1900)}$
6445	17	15	00.6	–21	00	20	4.39	+0.231	–0.209
6486	17	20	15.7	–24	05	00	4.17	+0.000	–0.116
6554/5	17	30	12.3	+55	15	09	4.88	+0.139	+0.055
6554/5	17	30	17.7	+55	14	28	4.87	+0.141	+0.054
6556	17	30	17.5	+12	37	58	2.08	+0.117	–0.227
6566	17	32	21.7	+68	11	56	5.05	–0.017	+0.134
6596	17	37	32.1	+68	48	15	4.80	–0.001	+0.322
6603	17	38	31.9	+04	36	32	2.77	–0.042	+0.159
6623	17	42	32.6	+27	46	45	3.42	–0.309	–0.747
6636/7	17	43	42.9	+72	11	53	4.58	+0.015	–0.267
6636/7	17	43	44.6	+72	12	22	5.79	+0.019	–0.278
6698	17	53	31.2	–09	45	41	3.34	–0.009	–0.119
6710	17	55	11.9	–03	41	02	4.62	+0.144	–0.046
6746	17	59	23.0	–30	25	31	2.99	–0.053	–0.185
6746	17	59	23.0	–30	25	31	2.99	–0.053	–0.185
6752	18	00	24.1	+02	31	22	4.03	+0.258	–1.094
6832	18	10	51.6	–36	47	30	3.11	–0.129	–0.166
6869	18	16	08.1	–02	55	29	3.26	–0.554	–0.697
6879	18	17	32.0	–34	25	55	1.85	–0.032	–0.125
6913	18	21	47.9	–25	28	37	2.81	–0.043	–0.185
6927	18	22	51.5	+72	41	22	3.57	+0.521	–0.356
6927	18	22	51.5	+72	41	22	3.57	+0.521	–0.356
7001	18	33	33.1	+38	41	26	0.03	+0.200	+0.285
7152	18	51	58.7	–37	14	16	4.87	–0.128	–0.097
7226/7	18	59	39.5	–37	12	25	4.93	+0.094	–0.273
7226/7	18	59	39.5	–37	12	25	4.99	+0.094	–0.273
7234	19	00	41.8	–27	49	00	3.32	–0.053	–0.249
7328	19	14	47.5	+53	11	02	3.77	+0.055	+0.125
7348	19	16	57.5	–40	48	14	3.97	+0.030	–0.121
7352	19	17	28.6	+73	10	12	4.45	–0.143	+0.111
7377	19	20	27.4	+02	54	55	3.36	+0.253	+0.083
7420	19	27	11.0	+51	31	00	3.79	+0.018	+0.130
7469	19	33	45.5	+49	59	22	4.48	–0.024	+0.256
7557	19	45	54.2	+08	36	15	0.77	+0.537	+0.387
7560	19	46	14.2	+10	09	55	5.11	+0.239	–0.138
7597	19	49	42.9	–26	33	53	4.70	+0.208	+0.083
7602	19	50	24.0	+06	09	25	3.71	+0.048	–0.482
7715	20	06	51.6	–12	54	38	5.85	+0.193	–0.193

Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]	*Modern indication of the star*	*Number of the star in the Almagest (Bailey's enumeration)*	*Coordinates in the Almagest*				*Brightness in the Almagest*	*D?*
			longitude		*latitude*			
			°	′	°	′		
7715*P.	2Xi2Cap	604	276	00	+8	00	6	
7715*P.	2Xi2Cap	604	279	00	+8	00	6	
7882	6BetDel	304	288	30	+32	00	3–4	
7896	7KapDel	303	288	40	+27	45	4	
7936	16PsiCap	611	280	50	–6	30	4	
7947	12Gam1Del	307	293	10	+33	10	3–4	
7949	53EpsCyg	168	300	50	+49	30	3	
7957	3EtaCep	79	339	20	+72	00	4	
8097	5GamEqu	313	296	20	+25	30	7	
8123	7DelEqu	314	297	40	+25	00	7	
8130*	65TauCyg	176	310	40	+49	40	4–3	
8162	5AlpCep	78	346	40	+69	00	3	
8213	36Cap	615	290	20	–6	00	5	
8264	23XiAqr	633	297	20	+6	15	5	
8278	40GamCap	623	294	50	–2	10	3	
8283	42Cap	625	296	50	+0	20	4	
8288	43KapCap	622	295	00	–4	30	4	
8322	49DelCap	624	296	20	–2	00	3	
8351	51MuCap	626	298	40	0	00	5	
8413	22NuPeg	330	308	00	+16	00	4	
8417	17XiCep	81	358	30	+65	30	5	
8425i.	AlpGru	1022	290	10	–22	15	4	
8353P.+T.	GamGru	1022	290	10	–22	15	4	
8430i.	24IotPeg	333	317	20	+34	15	4–3	
8430P.	24IotPeg	333	317	40	+34	15	4–3	
8450i.	26ThePeg	329	309	20	+16	30	3	
8450P.	26ThePeg	329	309	20	+16	50	3	
8494	23EpsCep	83	346	20	+60	15	5	
8499	43TheAqr	641	306	10	+3	00	4	
8518	48GamAqr	637	309	30	+8	45	3	
8544/5	53Aqr	648	304	40	–5	40	5	
8544/5	53Aqr	648	304	40	–5	40	5	
8558	55Zet1Aqr	639	312	00	+9	00	3	
8610	63KapAqr	651	315	00	+2	00	4	
8665	46XiPeg	326	320	30	+19	00	4	
8670	68Aqr	649	308	20	–10	00	5	
8684	48MuPeg	324	327	00	+29	30	4	
8694	32IotCep	82	7	30	+62	30	4–3	

Number of the star in the Bright Star Catalogue	Upright ascent RA(1900) in BS5			Inclination D(1900) in BS5			Value in BS5	Proper movement speed in BS4 (" / year × 1000)	
	h	m	s	°	′	″		$V_{RA(1900)}$	$V_{D(1900)}$
7715	20	06	51.6	–12	54	38	5.85	+0.193	–0.193
7715	20	06	51.6	–12	54	38	5.85	+0.193	–0.193
7882	20	32	51.5	+14	14	50	3.63	+0.112	–0.031
7896	20	34	16.3	+09	44	02	5.05	+0.318	+0.021
7936	20	40	10.5	–25	37	49	4.14	–0.049	–0.156
7947	20	42	00.3	+15	45	49	5.14	–0.032	–0.188
7949	20	42	09.8	+33	35	44	2.46	+0.355	+0.329
7957	20	43	15.3	+61	27	01	3.43	+0.091	+0.822
8097	21	05	28.7	+09	43	43	4.69	+0.059	–0.152
8123	21	09	36.6	+09	36	06	4.49	+0.046	–0.301
8130	21	10	47.9	+37	37	06	3.72	+0.159	+0.437
8162	21	16	11.5	+62	09	43	2.44	+0.150	+0.052
8213	21	23	01.3	–22	14	34	4.51	+0.138	–0.004
8264	21	32	25.7	–08	18	10	4.69	+0.113	–0.023
8278	21	34	33.1	–17	06	51	3.68	+0.188	–0.022
8283	21	36	06.6	–14	29	37	5.18	–0.122	–0.304
8288	21	37	04.5	–19	19	20	4.73	+0.146	–0.004
8322	21	41	31.3	–16	34	52	2.87	+0.262	–0.294
8351	21	47	50.7	–14	01	21	5.08	+0.309	+0.014
8413	22	00	38.1	+04	34	11	4.84	+0.109	+0.105
8417	22	00	53.7	+64	08	26	4.29	+0.208	+0.089
8425	22	01	55.9	–47	26	43	1.74	+0.130	–0.149
8353	21	47	52.5	–37	50	06	3.01	+0.103	–0.017
8430	22	02	21.2	+24	51	24	3.76	+0.299	+0.028
8430	22	02	21.2	+24	51	24	3.76	+0.299	+0.028
8450	22	05	09.3	+05	42	21	3.53	+0.275	+0.032
8450	22	05	09.3	+05	42	21	3.53	+0.275	+0.032
8494	22	11	20.9	+56	32	41	4.19	+0.444	+0.051
8499	22	11	33.4	–08	16	53	4.16	+0.117	–0.019
8518	22	16	29.5	–01	53	29	3.84	+0.129	+0.012
8544/5	22	21	08.3	–17	14	59	6.57	+0.260	–0.010
8544/5	22	21	08.7	–17	15	03	6.35	+0.221	+0.000
8558	22	23	40.8	–00	31	53	4.59	+0.178	+0.014
8610	22	32	34.6	–04	44	38	5.03	–0.070	–0.114
8665	22	41	41.8	+11	39	36	4.19	+0.233	–0.493
8670	22	42	10.9	–20	08	06	5.26	–0.102	–0.198
8684	22	45	10.5	+24	04	25	3.48	+0.148	–0.036
8694	22	46	07.1	+65	40	28	3.52	–0.067	–0.119

Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]	*Modern indication of the star*	*Number of the star in the Almagest (Bailey's enumeration)*	*Coordinates in the Almagest*				*Brightness in the Almagest*	*D?*
			longitude		*latitude*			
			°	'	°	'		
8697	49SigPeg	328	320	30	+16	00	5	
8728	24AlpPsA	1011	307	00	–20	20	1	
8775	53BetPeg	317	332	10	+31	00	2–3	
8782	83Aqr	653	317	40	–1	10	4	
8834	90PhiAqr	654	320	00	–0	30	4	
8841	91Psi1Aqr	656	319	00	–3	30	4	
8852	6GamPsc	675	324	10	+7	30	4	
8892	98Aqr	664	317	00	–14	10	4	
8905	68UpsPeg	320	335	00	+25	00	4	
8916	10ThePsc	677	328	10	+9	30	4	
8961	16LamAnd	343	352	10	+44	00	4	
8969	17IotPsc	678	330	40	+7	30	4	
8974	35GamCep	76	33	00	+64	15	4	
8984	18LamPsc	680	329	40	+3	30	4	
8988	105Ome2Aqr	660	323	10	–10	50	5	
9072	28OmePsc	681	336	00	+6	20	4	

(from page 647)

identifications and the coordinates of the Almagest from the work by Peters and Knobel ([1339]).

Symbol "T." marks the identifications from Toomer's translation of the Almagest ([1358]).

Symbol D marks the Almagest identifications of modern stars from the electronic version considered dubious by Manitius; this symbol is cited in the last column of the table.

Notes to Table P1.1

*BS 194 – Peters identifies the Almagest star 731 in Bailey's enumeration as star O.161, which neither has Flamsteed's number, nor Bayer's letter next to it.

*BS 235 – Peters identifies the Almagest star 730 in Bailey's enumeration as star 17 PhilCet.

*BS 812 – here Peters identifies the Almagest star as 87 Mu Ceti.

*BS 869 – Peters gives a double identification of the Almagest star – as 46 Rho3Ari and 45Rho2Ari; however, 45Rho2Ari is a slow star.

*BS 1453 – the same star is apparently referred to as Ups6Eri in the work of Peters, which must result from the confusion in the indication of this star (see [1358]).

*BS 2846 – Peters identifies this star differently (as 58 Gemini).

*BS 3769 – here Peters also suggests a different identification of the Almagest star (IIX 115), as well as different Almagest coordinates thereof: 35° 10' (longitude) and 22° 45' (latitude). (Next to vanishing luminosity-wise, according to the Almagest.)

*BS 3994 – Peters identifies this Almagest star (908 in Bailey's enumeration) as 40Ups2 of Hydra; however, the proper movement rate of this star is low.

*BS 4626 – Peters and Toomer identify this Almagest star as 5Zet Crv, which has a low proper movement rate, and not 10 Vir.

Number of the star in the Bright Star Catalogue	*Upright ascent RA(1900) in BS5*			*Inclination D(1900) in BS5*			*Value in BS5*	*Proper motion velocity in BS4 (" / year × 1000)*	
	h	m	s	°	′	″		$V_{RA(1900)}$	$V_{D(1900)}$
8697	22	47	19.9	+09	18	13	5.16	+0.522	+0.049
8728	22	52	07.6	–30	09	08	1.16	+0.336	–0.161
8775	22	58	55.5	+27	32	25	2.42	+0.188	+0.142
8782	22	59	56.9	–08	14	01	5.43	+0.126	+0.015
8834	23	09	08.6	–06	35	17	4.22	+0.037	–0.192
8841	23	10	39.1	–09	37	57	4.21	+0.369	–0.012
8852	23	11	58.8	+02	44	09	3.69	+0.759	+0.022
8892	23	17	43.1	–20	38	47	3.97	–0.122	–0.090
8905	23	20	23.2	+22	51	13	4.40	+0.193	+0.043
8916	23	22	53.7	+05	49	47	4.28	–0.122	–0.041
8961	23	32	40.0	+45	54	59	3.82	+0.160	–0.416
8969	23	34	48.3	+05	05	03	4.13	+0.375	–0.432
8974	23	35	14.3	+77	04	27	3.21	–0.065	+0.156
8984	23	36	56.6	+01	13	47	4.50	–0.130	–0.147
8988	23	37	32.2	–15	05	52	4.49	+0.096	–0.063
9072	23	54	10.5	+06	18	35	4.01	+0.152	–0.109

*BS 5838 – Peters and Toomer identify this Almagest star, which has the number of 542 in Bailey's enumeration, as a different star on the modern charts, which neither has Bayer's letter in its name, nor Flamsteed's number.

*BS 6271 – Peters identifies this Almagest star differently, as Zet1 Sco, whose proper movement speed is low.

*BS 7715 – Peters provides a double identification of the Almagest star here – as 2Xi 2Cap and 1Xi 1Cap (BS 7712); however, 1Xi 1Cap is a slow star.

*BS 8130 – Peters suggests a double identification for the Almagest star here: 65 Tau and 66 Ups in Corvus.

Explanatory notes for tables P1.2 and P1.3

Tables P1.2 and P1.3 contain data that concern the named stars. The actual stars are the same in both tables; however, their respective order is different. In table P1.2 the stars are arranged by name, and in table P1.3 – by their respective numbers in the Bright Star Catalogue (BS4, [1197]).

Tables P1.2 and P1.3 contain all the stars that were given individual names by the astronomers according to the Bright Star Catalogue ([1197]).

It is known that many (but not all) stars had proper names in the Middle Ages, such as Arcturus, Sirius, Aldebaran etc. One must keep it in mind that some of the stars got new names as time passed by; also, a single star's name could have several forms. In tables P1.2 and P1.3 the names of the stars have the same form as they do in the Bright Star Catalogue BS4 ([1197]).

Tables P1.1 and P1.2 (P1.3) intersect between each other. The matter is that the same star can simultaneously possess a high proper movement speed, which makes it eligible for table P1.1, and also a name of its own that places it in tables P1.2 and P1.3.

Table P1.2

Proper name of the star in the Bright Star Catalogue (BS4, BS5) [1197]	Star containing constellation	Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]
ACAMAR	Eri	897
ACHERNAR	Eri	472
Achird	Cas	219
Acrab	Sco	5984
ACRUX	Cru	4730
Acubens	Cnc	3572
ADARA	CMa	2618
Adhafera	Leo	4031
ADHARA	CMa	2618
Adhil	And	390
Adib	Dra	5291
AGENA	Cen	5267
Ain	Tau	1409
Ain al Rami	Sgr	7116
Ak	UMa	4301
Akrab	Sco	5984
Al Anchat al Nahr	Eri	850
Al Anf	Peg	8308
Al Anz	Aur	1605
Al Athfar	Lyr	6903
Al Atik	Per	1131
Al Baldah	Sgr	7264
Al Bali	Aqr	7950
Al Chiba	Crv	4623
Al Dhiba	Dra	5744
Al Dhihi	Dra	5744
Al Dibah	Dra	6396
Al Gieba	Leo	4057
Al Hammam	Peg	8634
Al Kaff al Jidmah	Cet	804
Al Kalb al Asad	Leo	3982
Al Kalb al Rai	Cep	8591
Al Kaphrah	UMa	4518
Al Kirdah	Cep	8417
Al Mankib	Ori	2061
Al Minliar al Ghurab	Crv	4623
Al Minliar al Shuja	Hya	3418
Al Minliaral Asad	Leo	3731
Al Mizar	And	337
Al Nair	Gru	8425
Al Nasi	Sgr	6746
Al Niyat	Sco	6165
Al Niyat	Sco	6084
Al Rakis	Dra	6370
Al Rescha	Psc	596
Al Richa	Psc	596
Al Rischa	Psc	596
Al Rukbah al Dajajah	Cyg	7851
Al Sanamal Nakah	Cas	21
Al Sheratain	Ari	553
Al Suhail al Muhlif	Vel	3207
Al Suhail al Wazn	Vel	3634
Al Tarf	Cnc	3249
Al Tinnin	Dra	5291
Al Wazor	CMa	2693
Aladfar	Lyr	7298
Aladfar	Lyr	6903
Alamak	And	603
Alanf	Peg	8308
Alanz	Aur	1605
Alaraph	Vir	5056
Alaraph	Vir	4540
Alaraph	Vir	4932
Alascha	Sco	6527
Alathfar	Lyr	6903
Albaldah	Sgr	7264
Albali	Aqr	7950
Albereo	Cyg	7417
ALBIREO	Cyg	7417
Alchiba	Crv	4623
Alchita	Crv	4623
Alcione	Tau	1165
ALCOR	UMa	5062
ALCYONE	Tau	1165

Proper name of the star in the Bright Star Catalogue (BS4, BS5) [1197]	*Star containing constellation*	*Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]*
ALDEBARAN	Tau	1457
Alderaimin	Cep	8162
ALDERAMIN	Cep	8162
Aldhafara	Leo	4031
Aldhafera	Leo	4031
Aldhibah	Dra	6396
Aldib	Dra	7310
Alfard	Hya	3748
Alfecca	Cra	7254
Alfirk	Cep	8238
Alga	Ser	7141
Algebar	On	1713
Algedi Prima	Cap	7747
Algedi Secunda	Cap	7754
Algeiba	Leo	4057
Algenib	Per	1017
ALGENIB	Peg	39
Algenubi	Leo	3873
ALGIEBA	Leo	4057
Algiedi	Cap	7747
ALGOL	Per	936
Algomeyla	CMi	2845
Algomeysa	Cmi	2943
Algorab	Crv	4757
Algoral	Crv	4757
Algorel	Crv	4757
Algores	Crv	4757
Alhajoth	Aur	1708
ALHENA	Gem	2421
Aliath	UMa	4905
ALIOTH	UMa	4905
ALKAID	UMa	5191
Alkalurops	Boo	5733
Alkaphrah	UMa	4518
Alkes	Crt	4287
Alkhiba	Crv	4623
Alkurhah	Cep	8417

Proper name of the star in the Bright Star Catalogue (BS4, BS5) [1197]	*Star containing constellation*	*Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]*
Almaac	And	603
Almaach	And	603
Almaack	And	603
ALMAAK	And	603
Almaaz	Aur	1605
Almak	And	603
Almuredin	Vir	4932
ALNAIR	Gru	8425
Alnasl	Sgr	6746
ALNATH	Tau	1791
Alnath	An	617
Alnihan	Ori	1903
ALNILAM	Ori	1903
Alnitah	Ori	1948
ALNITAK	Ori	1948
Alnitam	Ori	1903
Alniyat	Sco	6084
Alphaca	CrB	5793
Alphacca	CrB	5793
ALPHARD	Hya	3748
Alphart	Hya	3748
Alphecca	CrB	5793
ALPHEKKA	CrB	5793
Alpherat	And	15
ALPHERATZ	And	15
Alphirk	Cep	8238
Alrai	Cep	8974
Alrami	Sgr	7348
Alrescha	Psc	596
Alrischa	Psc	596
Alrisha	Psc	596
Alruccabah	UMi	424
Alsafi	Dra	7462
Alsahm	Sge	7479
Alschain	Aql	7602
Alschairn	Aql	7602
Alsciaukat	Lyn	3275

Proper name of the star in the Bright Star Catalogue (BS4, BS5) [1197]	*Star containing constellation*	*Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]*
ALSHAIN	Aql	7602
Alshat	Cap	7773
Alshemali	Leo	3905
Alsuhail	Vel	3634
ALTAIR	Aql	7557
Altais	Dra	7310
Altarf	Cnc	3249
Alterf	Leo	3773
Althafi	Dra	7462
Aludra	CMa	2827
Alula Australis	UMa	4375
Alula Borealis	UMa	4377
Alwaid	Dra	6536
Alwazi	Sgr	6746
Alwazn	CMa	2693
Alya	Ser	7141
Alzirr	Gem	2484
Amazon Star	Ori	1790
Ancha	Aqr	8499
Anchat	Eri	850
Andromeda's Head	And	15
Angel Stern	UMi	424
Angetenar	Eri	850
ANKAA	Phc	99
Anser	Vul	7405
ANTARES	Sco	6134
Antecanis	CMi	2943
Apollo	Gem	2891
ARCTURUS	Boo	5340
Arich	Vir	4825
Arided	Cyg	7924
Aridif	Cyg	7924
Arietis	Ari	617
Arkab Posterior	Sgr	7343
Arkab Prior	Sgr	7337
ARNEB	Lep	1865
Arrai	Cep	8974
Arrakis	Dra	6370

Proper name of the star in the Bright Star Catalogue (BS4, BS5) [1197]	*Star containing constellation*	*Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]*
Arrioph	Cyg	7924
Ascella	Sgr	7194
Aschcre	CMa	2491
Asellus Australis	Cnc	3461
Asellus Borealis	Cnc	3449
Asellus Primus	Boo	5404
Asellus Secundus	Boo	5350
Asellus Tertius	Boo	5329
Ashtaroth	CrB	5793
Asmidiske	Pup	3045
Asmidiske	Pup	3699
Aspidiske	Pup	3045
Aspidiske	Car	3699
Asterope	Tau	1151
Asuia	Dra	6536
Atair	Aql	7557
Athafi	Dra	7462
Athafiyy	Dra	7462
Ati	Per	1131
Atik	Per	1131
Atlas	Tau	1178
Atria	Tri	544
Auva	Vir	4910
Avior	Car	3307
Azelfafage	Cyg	8301
Azha	Eri	874
Azimech	Vir	5056
Azmidiske	Pup	3045
Azmidiske	Pup	3699
Baham	Peg	8450
Baten Kaitos	Cet	539
Batenkaitos	Cet	539
Bcteigeux	Ori	2061
Bctelgeuze	Ori	2061
Becrux	Cru	4853
Beid	Eri	1298
BELLATRIX	Ori	1790
Benatnasch	UMa	5191

Proper name of the star in the Bright Star Catalogue (BS4, BS5) [1197]	*Star containing constellation*	*Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]*
Benetnasch	UMa	5191
Benetnash	UMa	5191
BETELGEUSE	Ori	2061
Biham	Peg	8450
Botein	Ari	951
Brachium	Sco	5603
Bunda	Agr	8264
Caiam	Her	6117
Cajam	Her	6117
Calbalakrab	Sco	6134
Calx	Gem	2286
Canicula	CMa	2491
CANOPUS	Car	2326
CAPELLA	Aur	1708
Caph	Cas	21
Caput Trianguli	Tri	544
CASTOR	Gem	2891
Castula	Cas	265
Castula	Cas	253
Cclicno	Tau	1140
Cebalrai	Oph	6603
Ceginus	Boo	5435
Celaeno	Tau	1140
Celb-al-Rai	Oph	6603
Celeno	Tau	1140
Chaph	Cas	21
Chara	CVn	4785
Chclcb	Oph	6603
Chenan	Leo	4359
Chort	Leo	4359
Clava	Boo	5733
COR CAROLI	CVn	4915
Cor Hydrae	Hya	3748
Cor Lconis	Leo	3982
Cor Scorpii	Sco	6134
Cor Serpentis	Scr	5854
Cor Tauri	Tau	1457
Cornu	Sco	5603
Coxa	Leo	4359
Cujam	Her	6117
Cursa	Eri	1666
Cymbae	Phe	99
Cynosura	UMi	424
Dabih	Cap	7776
Dabih Major	Cap	7776
Dabih Minor	Cap	7775
Demon Star	Per	936
Deneb	Cet	334
Deneb	Aql	7235
Deneb	Leo	4534
DENEB	Cyg	7924
Deneb	Aql	7176
Deneb	Del	7852
Deneb Aleet	Leo	4534
Deneb Algedi	Cap	8322
Deneb Algenubi	Cet	334
Deneb Algiedi	Cap	8322
Deneb Cygni	Cyg	7924
Deneb Dulfim	Del	7852
Deneb el Adige	Cyg	7924
Deneb el Delphinus	Del	7852
Deneb el Okab	Aql	7235
Deneb el Okab	Aql	7176
Deneb Kaitos	Cet	188
Deneb Kaitos Senubiy	Cet	188
Deneb Kaitos Shamaliy	Cet	74
Deneb Kaitos Shemali	Cet	74
DENEBOLA	Leo	4534
Dhabih	Cap	7776
Dhalim	Eri	1666
Dheneb	Cet	334
Dhur	Leo	4357
Diadem	Corn	4968
Difda	Cet	188
Difda al Auwel	PsA	8728
Difda al Thani	Cet	188

Proper name of the star in the Bright Star Catalogue (BS4, BS5) [1197]	*Star containing constellation*	*Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]*
DIPHDA	Cet	188
Dog Star	CMa	2491
Dragon's Tail	Dra	5291
Driver	Aur	1708
Dschubba	Sco	5953
Dsiban	Dra	6636
Dubb	UMa	4301
DUBHE	UMa	4301
Duhr	Leo	4357
Dziban	Dra	6636
Ed Asich	Dra	5744
El Acola	UMa	4375
El Ghoul	Per	936
El Kaprah	UMa	3594
El Karidab	Sgr	6859
El Khereb	Peg	8880
El Koprah	UMa	4518
El Melik	Aqr	8414
El Nath	Ari	617
EL NATH	Tau	1791
El Phekrah	UMa	4069
El Rakis	Dra	6370
El Rischa	Psc	596
El-Dhalim	Eri	1666
El-Difda	Cet	188
El-Khereb	Peg	8880
Elacrab	Sco	5984
Eldsich	Dra	5744
Electra	Tau	1142
Elgebar	Ori	1713
Elgomaisa	CMi	2943
Elkeid	UMa	5191
Elkhiffa Australis	Lib	5531
Elkhiffa Borealis	Lib	5685
Elmathalleth	Tri	544
Elmuthalleth	Tri	544
Eltanin	Dra	6705
Enf	Peg	8308

Proper name of the star in the Bright Star Catalogue (BS4, BS5) [1197]	*Star containing constellation*	*Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]*
ENIF	Peg	8308
Eniph	Peg	8308
Enir	Peg	8308
Er Rai	Cep	8974
Er Rakis	Dra	6370
Erakis	Cep	8316
Errai	Cep	8974
Errakis	Dra	6370
ETAMIN	Dra	6705
Etanin	Dra	6705
Ettanin	Dra	6705
Falx Italica	Boo	5533
Fidis	Lyr	7001
First Frog	PsA	8728
First Star in Aries	Ari	545
Fom	Peg	8308
FOMALHAUT	PsA	8728
Fornacis	For	963
Fum Al Samakah	Psc	8773
Furud	CMa	2282
Gacrux	Cru	4763
Gallina	Cyg	7924
Garnet Star	Cep	8316
Gemma	CrB	5793
Genam	Dra	6688
Gianfar	Dra	4434
Giansar	Dra	4434
Giausar	Dra	4434
Giauzar	Dra	4434
Giedi Prima	Cap	7747
Giedi Secunda	Cap	7754
Gienah	Cyg	7949
Gienah	Crv	4662
Gienah Cygni	Cyg	7949
Gienah Ghurab	Crv	4662
Gildun	UMi	6789
Gnosia	CrB	5793
Gnosia Stella Coronae	CrB	5793

Proper name of the star in the Bright Star Catalogue (BS4, BS5) [1197]	*Star containing constellation*	*Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]*
Goat Star	Aur	1708
Gomeisa	Cmi	2845
Gomeisa	CMi	2943
Gomelza	CMi	2845
Gorgona	Per	936
Gorgonea Prima	Per	936
Gorgonea Quarta	Per	947
Gorgonea Secunda	Per	879
Gorgonea Tcrtia	Per	921
Graffias	Sco	5984
Grafias	Sco	5984
Gredi	Cap	7754
Gredi	Cap	7754
Grumium	Dra	6688
HADAR	Cen	5267
Haedus	Aur	1612
HAMAL	Ari	617
Hamul	Ari	617
Haris	Boo	5435
Harp Star	Leo	7001
Hassaleh	Aur	1577
Hastorang	PsA	8728
Hatysa	On	1899
Head of Hydros	Hyi	591
Head of Medusa	Per	936
Head of Phoenix	Phe	99
Heka	Ori	1879
Hemal	Ari	617
Hercules	Gem	2990
Heze	Vir	5107
Hoedus I	Aur	1612
Hoedus II	Aur	1641
Homam	Peg	8634
Homan	Peg	8634
Humam	Peg	8634
Hyadum I	Tau	1346
Hyadum II	Tau	1373
Hyadum Primus	Tau	1346

Proper name of the star in the Bright Star Catalogue (BS4, BS5) [1197]	*Star containing constellation*	*Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]*
Icalurus	Boo	5733
Iclarkrau	Sco	5953
Icu of Babylon	Aur	1708
Inkalunis	Boo	5733
Isis	CMa	2657
Isis	CMa	2491
IZAR	Boo	5506
Jabbah	Sco	6027
Jed	Oph	6056
Jewel	CrB	5793
Job's Star	Boo	5340
Jugum	Lyr	7178
Juza	Dra	4434
Kabeleced	Leo	3982
Kaff	Cas	21
Kaffa	UMa	4660
Kaffaljidhma	Cet	804
Kaitain	Psc	596
Kajam	Her	6117
Kalb	Leo	3982
Kalb al Akrab	Sco	6134
Kalb al Rai	Oph	6603
Kalbalrai	Oph	6603
Kalbelaphard	Hya	3748
KAUS AUSTRALIS	Sgr	6879
Kaus Borealis	Sgr	6913
Kaus Media	Sgr	6859
Kaus Meridionalis	Sgr	6859
Keid	Eri	1325
Kelb	Leo	3982
Kelb Alrai	Oph	6603
Kelb-al-Rai	Oph	6603
Kerb	Peg	8880
Kied	Eri	1325
Kiffa Australis	Lib	5531
Kiffa Borealis	Lib	5685
Kitalpha	Equ	8131
Kitalphar	Equ	8131

Proper name of the star in the Bright Star Catalogue (BS4, BS5) [1197]	*Star containing constellation*	*Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]*
Kitel Phard	Equ	8131
KOCAB	UMi	5563
Kochab	UMi	5563
Kochah	UMi	5563
Komephoros	Her	6148
Korneforos	Her	6148
Kraz	Crv	4786
Ksora	Cas	403
Kuma	Dra	6555
Kurhah	Cep	8417
Kursa	Eri	1666
La Superba	CVn	4945
Lesath	Sco	6527
Lesath	Sco	6508
Lesath	Sco	6027
Leschath	Sco	6508
Lesuth	Sco	6508
Lesuth	Sco	6527
Lodestar	UMi	424
Lost Pleiad	Tau	1140
Lucida Cymbae	Phe	99
Maasym	Her	6526
Mabsuthat	Lyn	3275
Maia	Tau	1149
Maiaplacidus	Car	3685
Marchab	Peg	8781
Marfac	Per	1017
Marfak	Cas	321
Marfak	Cas	343
Marfak	Per	1017
Marfak	Her	6008
Marfic	Oph	6149
Marfic	Her	6008
Marfik	Oph	6149
Marfik	Her	6008
Markab	Peg	8880
Markab	Pup	2948
MARKAB	Peg	8781

Proper name of the star in the Bright Star Catalogue (BS4, BS5) [1197]	*Star containing constellation*	*Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]*
Markeb	Peg	8880
Markeb	Pup	2948
Marrha	Boo	5533
Marsic	Oph	6149
Marsik	Her	6008
Masym	Her	6526
Matar	Peg	8650
Mebsuta	Gem	2473
Mebusta	Gem	2473
Media	Sgr	6859
Megrcs	UMa	4660
MEGREZ	UMa	4660
Meissa	Ori	1879
Mekab	Cet	911
Mekbuda	Gem	2650
Melboula	Gem	2473
Melucta	Gem	2473
Menchib	Per	1228
Menkab	Cet	911
Menkalina	Aur	2088
Menkalinan	Aur	2088
Menkar	Cet	896
MENKAR	Cet	911
Menkent	Cen	5288
Menkhib	Per	1228
Menkib	Per	1228
Menkib	Peg	8775
Merach	And	337
MERAK	UMa	4295
Meres	Boo	5602
Merez	Boo	5602
Merga	Boo	5533
Meridiana	Cra	7254
Merope	Tau	1156
Mesarthim	Ari	546
Mesartim	Ari	546
Metallah	Tri	544
Miaplacidus	Car	3685

Proper name of the star in the Bright Star Catalogue (BS4, BS5) [1197]	*Star containing constellation*	*Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]*
Mimosa	Cru	4853
Minelauva	Vir	4910
Minelauva	Vir	4540
Minkar	Crv	4630
MINTAKA	Ori	1852
Mintika	Ori	1852
MIRA	Cet	681
Mirac	And	337
Mirac	Boo	5506
MIRACH	And	337
Mirach	Boo	5506
Mirak	Boo	5506
Mirak	UMa	4295
Miram	Per	834
Mirfak	Her	6008
Mirfak	Per	1017
MIRPHAK	Per	1017
Mirza	UMa	5054
Mirza	CMa	2657
Mirza	CMa	2294
Mirzak	Per	1017
Mirzam	CMa	2294
Misam	Per	
Misam	Per	941
Misam	Her	6526
Mismar	UMi	424
Mizar	And	337
Mizar	Boo	5506
MIZAR	UMa	5054
Mizat	UMa	5054
Monkar	Cet	911
Mothallah	Tri	544
Mufrid	Boo	5235
Mufride	Boo	5235
Muliphein	CMa	2657
Muliphen	CMa	2657
Muphrid	Boo	5235
Muphridc	Boo	5235

Proper name of the star in the Bright Star Catalogue (BS4, BS5) [1197]	*Star containing constellation*	*Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]*
Murzim	CMf	2294
Muscida	UMa	3403
Muscida	UMa	3323
Museida	UMa	3403
Nair al Zaurak	Phc	99
Nairal Saif	Ori	1899
Naos	Pup	3165
Nash	Sgr	6746
Nashira	Cap	8278
Nath	Tau	1791
Navigatoria	UMi	424
Nekkar	Boo	5602
Nibal	Lep	1829
Nicolaus	Del	7906
NIHAL	Lep	1829
Nodus I	Dra	6396
Nodus II	Dra	7310
NUNKI	Sgr	7121
Nusakan	CrB	5747
Nushaba	Sgr	6746
Oculus Boreus	Tau	1409
Okda	Psc	596
Os Pegasi	Peg	8308
Os Piscis Meridiani	PsA	8728
Os Piscis Notii	PsA	8728
Osiris	CMa	2491
Palilicium	Tau	1457
Parilicium	Tau	1457
Peacock	Pav	7790
Phacd	UMa	4554
Phact	Col	1956
Phad	Col	1956
PHAD	UMa	4554
Phaet	Col	1956
Phakt	Col	1956
Phecda	UMa	4554
Phegda	UMa	4554
Phekda	UMa	4554

Proper name of the star in the Bright Star Catalogue (BS4, BS5) [1197]	*Star containing constellation*	*Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]*
Phekha	UMa	4554
Pherkad	UMi	5735
Pherkad Major	UMi	5735
Pherkad Minor	UMi	5714
Pherkard	UMi	6789
Phoenice	UMi	424
Phurud	CMa	2282
Pishpai	Gem	2286
Plaskett's Star		2422
Pleione	Tau	1180
POLARIS	UMi	424
Polaris Australis	Oct	7228
Pole Star	UMi	424
POLLUX	Gem	2990
Porrima	Vir	4825
Pracsacpe	Cnc	3429
Praecipua	LMi	4247
Praepes	Gem	2216
Prima Giedi	Cap	7747
PROCYON	CMi	2943
Propus	Gem	2821
Propus	Gem	2216
Protrygetor	Vir	4932
Pulcherrima	Boo	5506
Rana	Eri	1136
Rana Secunda	Cet	188
Ras al Asad	Leo	3905
Ras al Mothallath	Tri	544
Ras al Muthallath	Tri	544
Ras Algethi	Her	6406
Ras Alhagua	Oph	6556
Ras Alhague	Oph	6556
Ras Elascd Australis	Leo	3873
Ras Elased Borealis	Leo	3905
Ras Hammel	Ari	617
Ras-al-hague	Oph	6556
Rasaben	Dra	6705
Rasalas	Leo	3905

Proper name of the star in the Bright Star Catalogue (BS4, BS5) [1197]	*Star containing constellation*	*Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]*
Rasalegti	Her	6406
RASALGETHI	Her	6406
RASALHAGUE	Oph	6556
Rastaban	Dra	6705
Rastaban	Dra	6536
Rastaben	Dra	6536
Reda	Aql	7525
REGULUS	Leo	3982
Rescha	Psc	596
Rex	Leo	3982
RIGEL	Ori	1713
Rigel Kent	Cen	5459
Rigel Kentaurus	Cen	5459
RIGIL KENT	Cen	5459
Rigil Kentaurus	Cen	5459
Riji al Awwa	Vir	5487
Rotanen	Del	7882
Rotanev	Del	7882
Rucha	Cas	403
Ruchba	Cyg	7851
Ruchbah	Cas	542
Ruchbah	Cas	403
Ruchbah ur Ramih	Sgr	7348
Rukbat	Sgr	7348
Rukbat al Rami	Sgr	7348
Rukbat al-dejajah	Cyg	7851
Rutilicus	Her	6148
Saad el Melik	Aqr	8414
Saad el Sund	Aqr	8232
Sabik	Oph	6378
Saclateni	Ori	1612
Sad es Saud	Aqr	8232
Sad-al-melik	Aqr	8414
Sadachbia	Aqr	8518
Sadal Melik	Aqr	8414
Sadal Suud	Aqr	8232
Sadalachbia	Aqr	8518
Sadalbari	Peg	8684

Proper name of the star in the Bright Star Catalogue (BS4, BS5) [1197]	*Star containing constellation*	*Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]*
Sadalmeiek	Aqr	8414
SADALMELIK	Aqr	8414
Sadalsud	Aqr	8232
Sadalsund	Aqr	8232
Sadalsuud	Aqr	8232
Sadatoni	Ori	1612
Sadir	Cyg	7796
Sadira	Sgr	7121
Sadlamulk	Aqr	8414
Sador	Cyg	7796
Sadr	Cyg	7796
Sadr el dedschadsche	Cyg	7796
Saidak	UMa	5062
SAIPH	Ori	2004
Saiph	Ori	1899
Saiph	Ori	1788
Salm	Peg	8880
Sargas	Sco	6553
Sarin	Her	6410
Sartan	Cnc	3572
Scalovin	Del	7906
Sceptrum	Eri	1481
Schcdir	Cas	168
Scheat	Aqr	8709
SCHEAT	Peg	8775
Schedar	Cas	168
Scheddi	Cap	8322
Schemali	Cet	74
Scutulum	Car	3699
Seat Alpheras	Peg	8775
Second Frog	Cct	188
Secunda Giedi	Cap	7754
Segin	Cas	542
Seginus	Boo	5435
Sertan	Cnc	3572
Sham	Sge	7479
Sharatan	Ari	553
SHAULA	Sco	6527
Sheat	Aqr	8709
Sheat	Peg	8775
Sheddi	Cap	8322
SHEDIR	Cas	168
SHELIAK	Lyr	7106
Shelyak	Lyr	7106
Shemali	Cet	74
Shepherd's Star	Aur	1708
Sheratan	Ari	553
Shiliak	Lyr	7106
Singer	Aur	1708
Sirah	And	15
SIRIUS	CMa	2491
Sirrah	And	15
Situla	Aqr	8610
Skat	Aqr	8709
SPICA	Vir	5056
Spica Virginis	Vir	5056
Star of Arcady	UMi	424
Sterope	Tau	1151
Sualocin	Del	7906
Subra	Leo	3852
Suha	UMa	5062
Suhail	Vel	3634
Suhail	Car	2326
Suhail al Mulif	Vel	3207
Suhail al Wazn	Vel	3634
Suhail Hadar	Pup	3165
Suhel	Car	2326
Sulafat	Lyr	7178
Sulaphat	Lyr	7178
Superba	CVn	4846
Svalocin	Del	7906
Syrma	Vir	5338
Tabit	Ori	1855
Tabit	Ori	1543
Talita	UMa	3569
Talitha	UMa	3569

Proper name of the star in the Bright Star Catalogue (BS4, BS5) [1197]	*Star containing constellation*	*Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]*
Tania Australis	UMa	4069
Tania Borealis	UMa	4033
Tarazad	Aql	7525
TARAZED	Aql	7525
Tayeta	Tau	1145
Taygeta	Tau	1145
Taygete	Tau	1145
Tcrebellum	Sgr	7604
Tegmen	Cnc	3208
Tegminc	Cnc	3208
Tejat	Gem	2286
Tejat Posterior	Gem	2286
Tejat Prior	Gem	2216
Thabit	Ori	1855
Thecmim	Eri	1464
THUBAN	Dra	5291
Toliman	Cen	5459
Tolimann	Cen	5459
Torcularis Septentrionalis	Psc	510
Tramontana	UMi	424
Turais	Car	3699
Tureis	Car	3699
Tyl	Dra	7582
Unuk	Ser	5854
Unuk al Hay	Ser	5854
Unuk Elhaia	Ser	5854
UNUKALHAI	Ser	5854
Unukalhay	Ser	5854
Urkab Posterior	Sgr	7343
Urkab Prior	Sgr	7337
Variabilis Coronae	CrB	5880
VEGA	Lyr	7001
Venabulum	Boo	5733
Venator	Del	7882
Vendemiatrix	Vir	4932
Vespertilio	Sco	6134
Vildiur	UMi	6789
Vindemiator	Vir	4932

Proper name of the star in the Bright Star Catalogue (BS4, BS5) [1197]	*Star containing constellation*	*Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]*
VINDEMIATRIX	Vir	4932
Wasat	Gem	2777
Wazn	Col	2040
Wega	Lyr	7001
Wesat	Gem	2777
Wesen	CMa	2693
Wezen	CMa	2693
Wezn	Col	2040
Yad	Oph	6056
Yed	Oph	6056
Yed Posterior	Oph	6075
Yed Prior	Oph	6056
Yildun	UMi	6789
Yilduz	UMi	424
Yilduz	UMi	6789
Zaniah	Vir	4689
Zarijan	Vir	4540
Zaurac	Eri	1231
Zaurack	Eri	1231
ZAURAK	Eri	1231
Zavijah	Vir	4540
Zavijava	Vir	4540
Zavyava	Vir	4540
Zawijah	Vir	4540
Zenith Star	Dra	6705
Zibal	Eri	984
Zibel	Eri	984
Zosca	Leo	4357
Zosma	Leo	4357
Zozca	Leo	4357
Zozma	Leo	4357
Zubcneschamali	Lib	5685
Zuben el Chamali	Lib	5685
Zuben el Genubi	Lib	5531
Zuben el Genubi	Sco	5603
Zuben el Hakrabi	Lib	5787
Zuben Elakrab	Lib	5787
Zuben Elakribi	Lib	5586

Proper name of the star in the Bright Star Catalogue (BS4, BS5) [1197]	*Star containing constellation*	*Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]*
Zuben Elgenubi	Lib	5531
Zuben Elgenubi	Sco	5603
Zuben Elschemali	Lib	5685
Zuben Hakrabi	Lib	5723
Zuben Hakrabi	Sco	5603
Zuben Hakrabi	Lib	5622
Zuben Hakraki	Lib	5787

Proper name of the star in the Bright Star Catalogue (BS4, BS5) [1197]	*Star containing constellation*	*Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]*
Zubeneig	Lib	5685
Zubenelgenubi	Lib	5531
Zubenesch	Lib	5685
Zubenhakrabi	Lib	5787
Zubra	Leo	4357
Zujj al Nushshabah	Sgr	6746

Table P1.3

Proper name of the star in the Bright Star Catalogue (BS4, BS5) [1197]	*Star containing constellation*	*Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]*
Alpherat	And	15
ALPHERATZ	And	15
Andromeda's Head	And	15
Sirah	And	15
Sirrah	And	15
Al Sanamal Nakah	Cas	21
Caph	Cas	21
Chaph	Cas	21
Kaff	Cas	21
ALGENIB	Peg	39
Deneb Kaitos Shamaliy	Cet	74
Deneb Kaitos Shemali	Cet	74
Schemali	Cet	74
Shemali	Cet	74
ANKAA	Phc	99
Cymbae	Phe	99
Head of Phoenix	Phe	99
Lucida Cymbae	Phe	99
Nair al Zaurak	Phc	99
Schcdir	Cas	168
Schedar	Cas	168
SHEDIR	Cas	168
Deneb Kaitos	Cet	188
Deneb Kaitos Senubiy	Cet	188
Difda	Cet	188
Difda al Thani	Cet	188
DIPHDA	Cet	188
El-Difda	Cet	188
Rana Secunda	Cet	188
Second Frog	Cct	188
Achird	Cas	219
Castula	Cas	253
Castula	Cas	265
Marfak	Cas	321
Deneb	Cet	334
Deneb Algenubi	Cet	334
Dheneb	Cet	334
Al Mizar	And	337
Merach	And	337
Mirac	And	337
MIRACH	And	337
Mizar	And	337
Marfak	Cas	343
Adhil	And	390
Ksora	Cas	403
Rucha	Cas	403
Ruchbah	Cas	403
Alruccabah	UMi	424
Angel Stern	UMi	424
Cynosura	UMi	424
Lodestar	UMi	424
Mismar	UMi	424
Navigatoria	UMi	424
Phoenice	UMi	424
POLARIS	UMi	424
Pole Star	UMi	424
Star of Arcady	UMi	424
Tramontana	UMi	424
Yilduz	UMi	424
ACHERNAR	Eri	472
Torcularis Septentrionalis	Psc	510
Baten Kaitos	Cet	539
Batenkaitos	Cet	539
Ruchbah	Cas	542
Segin	Cas	542
Atria	Tri	544
Caput Trianguli	Tri	544
Elmathalleth	Tri	544
Elmuthalleth	Tri	544
Metallah	Tri	544
Mothallah	Tri	544
Ras al Mothallath	Tri	544
Ras al Muthallath	Tri	544
First Star in Aries	Ari	545

Proper name of the star in the Bright Star Catalogue (BS4, BS5) [1197]	*Star containing constellation*	*Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]*
Mesarthim	Ari	546
Mesartim	Ari	546
Al Sheratain	Ari	553
Sharatan	Ari	553
Sheratan	Ari	553
Head of Hydros	Hyi	591
Al Rescha	Psc	596
Al Richa	Psc	596
Al Rischa	Psc	596
Alrescha	Psc	596
Alrischa	Psc	596
Alrisha	Psc	596
El Rischa	Psc	596
Kaitain	Psc	596
Okda	Psc	596
Rescha	Psc	596
Alamak	And	603
Almaac	And	603
Almaach	And	603
Almaack	And	603
ALMAAK	And	603
Almak	And	603
Alnath	An	617
Arietis	Ari	617
El Nath	Ari	617
HAMAL	Ari	617
Hamul	Ari	617
Hemal	Ari	617
Ras Hammel	Ari	617
MIRA	Cet	681
Al Kaff al Jidmah	Cet	804
Kaffaljidhma	Cet	804
Miram	Per	834
Al Anchat al Nahr	Eri	850
Anchat	Eri	850
Angetenar	Eri	850
Azha	Eri	874

Proper name of the star in the Bright Star Catalogue (BS4, BS5) [1197]	*Star containing constellation*	*Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]*
Gorgonea Secunda	Per	879
Menkar	Cet	896
ACAMAR	Eri	897
Mekab	Cet	911
Menkab	Cet	911
MENKAR	Cet	911
Monkar	Cet	911
Gorgonea Tcrtia	Per	921
ALGOL	Per	936
Demon Star	Per	936
El Ghoul	Per	936
Gorgona	Per	936
Gorgonea Prima	Per	936
Head of Medusa	Per	936
Misam	Per	941
Gorgonea Quarta	Per	947
Botein	Ari	951
Fornacis	For	963
Zibal	Eri	984
Zibel	Eri	984
Algenib	Per	1017
Marfac	Per	1017
Marfak	Per	1017
Mirfak	Per	1017
MIRPHAK	Per	1017
Mirzak	Per	1017
Al Atik	Per	1131
Ati	Per	1131
Atik	Per	1131
Rana	Eri	1136
Cclicno	Tau	1140
Celaeno	Tau	1140
Celeno	Tau	1140
Lost Pleiad	Tau	1140
Electra	Tau	1142
Tayeta	Tau	1145
Taygeta	Tau	1145

Proper name of the star in the Bright Star Catalogue (BS4, BS5) [1197]	*Star containing constellation*	*Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]*
Taygete	Tau	1145
Maia	Tau	1149
Asterope	Tau	1151
Sterope	Tau	1151
Merope	Tau	1156
Alcione	Tau	1165
ALCYONE	Tau	1165
Atlas	Tau	1178
Pleione	Tau	1180
Menchib	Per	1228
Menkhib	Per	1228
Menkib	Per	1228
Zaurac	Eri	1231
Zaurack	Eri	1231
ZAURAK	Eri	1231
Beid	Eri	1298
Keid	Eri	1325
Kied	Eri	1325
Hyadum I	Tau	1346
Hyadum Primus	Tau	1346
Hyadum II	Tau	1373
Ain	Tau	1409
Oculus Boreus	Tau	1409
ALDEBARAN	Tau	1457
Cor Tauri	Tau	1457
Palilicium	Tau	1457
Parilicium	Tau	1457
Thecmim	Eri	1464
Sceptrum	Eri	1481
Tabit	Ori	1543
Hassaleh	Aur	1577
Al Anz	Aur	1605
Alanz	Aur	1605
Almaaz	Aur	1605
Haedus	Aur	1612
Hoedus I	Aur	1612
Saclateni	Ori	1612
Sadatoni	Ori	1612

Proper name of the star in the Bright Star Catalogue (BS4, BS5) [1197]	*Star containing constellation*	*Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]*
Hoedus II	Aur	1641
Cursa	Eri	1666
Dhalim	Eri	1666
El-Dhalim	Eri	1666
Kursa	Eri	1666
Alhajoth	Aur	1708
CAPELLA	Aur	1708
Driver	Aur	1708
Goat Star	Aur	1708
Icu of Babylon	Aur	1708
Shepherd's Star	Aur	1708
Singer	Aur	1708
Algebar	On	1713
Elgebar	Ori	1713
RIGEL	Ori	1713
Saiph	Ori	1788
Amazon Star	Ori	1790
BELLATRIX	Ori	1790
ALNATH	Tau	1791
EL NATH	Tau	1791
Nath	Tau	1791
Nibal	Lep	1829
NIHAL	Lep	1829
MINTAKA	Ori	1852
Mintika	Ori	1852
Tabit	Ori	1855
Thabit	Ori	1855
ARNEB	Lep	1865
Heka	Ori	1879
Meissa	Ori	1879
Hatysa	On	1899
Nairal Saif	Ori	1899
Saiph	Ori	1899
Alnihan	Ori	1903
ALNILAM	Ori	1903
Alnitam	Ori	1903
Alnitah	Ori	1948
ALNITAK	Ori	1948

Proper name of the star in the Bright Star Catalogue (BS4, BS5) [1197]	*Star containing constellation*	*Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]*
Phact	Col	1956
Phad	Col	1956
Phaet	Col	1956
Phakt	Col	1956
SAIPH	Ori	2004
Wazn	Col	2040
Wezn	Col	2040
Al Mankib	Ori	2061
Bcteigeux	Ori	2061
Bctelgeuze	Ori	2061
BETELGEUSE	Ori	2061
Menkalina	Aur	2088
Menkalinan	Aur	2088
Praepes	Gem	2216
Propus	Gem	2216
Tejat Prior	Gem	2216
Furud	CMa	2282
Phurud	CMa	2282
Calx	Gem	2286
Pishpai	Gem	2286
Tejat	Gem	2286
Tejat Posterior	Gem	2286
Mirza	CMa	2294
Mirzam	CMa	2294
Murzim	CMf	2294
CANOPUS	Car	2326
Suhail	Car	2326
Suhel	Car	2326
ALHENA	Gem	2421
Plaskett's Star		2422
Mebsuta	Gem	2473
Mebusta	Gem	2473
Melboula	Gem	2473
Melucta	Gem	2473
Alzirr	Gem	2484
Aschcre	CMa	2491
Canicula	CMa	2491
Dog Star	CMa	2491

Proper name of the star in the Bright Star Catalogue (BS4, BS5) [1197]	*Star containing constellation*	*Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]*
Isis	CMa	2491
Osiris	CMa	2491
SIRIUS	CMa	2491
ADARA	CMa	2618
ADHARA	CMa	2618
Mekbuda	Gem	2650
Isis	CMa	2657
Mirza	CMa	2657
Muliphein	CMa	2657
Muliphen	CMa	2657
Al Wazor	CMa	2693
Alwazn	CMa	2693
Wesen	CMa	2693
Wezen	CMa	2693
Wasat	Gem	2777
Wesat	Gem	2777
Propus	Gem	2821
Aludra	CMa	2827
Algomeyla	CMi	2845
Gomeisa	Cmi	2845
Gomelza	CMi	2845
Apollo	Gem	2891
CASTOR	Gem	2891
Algomeysa	Cmi	2943
Antecanis	CMi	2943
Elgomaisa	CMi	2943
Gomeisa	CMi	2943
PROCYON	CMi	2943
Markab	Pup	2948
Markeb	Pup	2948
Hercules	Gem	2990
POLLUX	Gem	2990
Asmidiske	Pup	3045
Aspidiske	Pup	3045
Azmidiske	Pup	3045
Naos	Pup	3165
Suhail Hadar	Pup	3165
Al Suhail al Muhlif	Vel	3207

Proper name of the star in the Bright Star Catalogue (BS4, BS5) [1197]	*Star containing constellation*	*Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]*
Suhail al Mulif	Vel	3207
Tegmen	Cnc	3208
Tegminc	Cnc	3208
Al Tarf	Cnc	3249
Altarf	Cnc	3249
Alsciaukat	Lyn	3275
Mabsuthat	Lyn	3275
Avior	Car	3307
Muscida	UMa	3323
Muscida	UMa	3403
Museida	UMa	3403
Al Minliar al Shuja	Hya	3418
Pracsacpe	Cnc	3429
Asellus Borealis	Cnc	3449
Asellus Australis	Cnc	3461
Talita	UMa	3569
Talitha	UMa	3569
Acubens	Cnc	3572
Sartan	Cnc	3572
Sertan	Cnc	3572
El Kaprah	UMa	3594
Al Suhail al Wazn	Vel	3634
Alsuhail	Vel	3634
Suhail	Vel	3634
Suhail al Wazn	Vel	3634
Maiaplacidus	Car	3685
Miaplacidus	Car	3685
Asmidiske	Pup	3699
Aspidiske	Car	3699
Azmidiske	Pup	3699
Scutulum	Car	3699
Turais	Car	3699
Tureis	Car	3699
Al Minliaral Asad	Leo	3731
Alfard	Hya	3748
ALPHARD	Hya	3748
Alphart	Hya	3748
Cor Hydrae	Hya	3748

Proper name of the star in the Bright Star Catalogue (BS4, BS5) [1197]	*Star containing constellation*	*Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]*
Kalbelaphard	Hya	3748
Alterf	Leo	3773
Subra	Leo	3852
Algenubi	Leo	3873
Ras Elascd Australis	Leo	3873
Alshemali	Leo	3905
Ras al Asad	Leo	3905
Ras Elased Borealis	Leo	3905
Rasalas	Leo	3905
Al Kalb al Asad	Leo	3982
Cor Lconis	Leo	3982
Kabeleced	Leo	3982
Kalb	Leo	3982
Kelb	Leo	3982
REGULUS	Leo	3982
Rex	Leo	3982
Adhafera	Leo	4031
Aldhafara	Leo	4031
Aldhafera	Leo	4031
Tania Borealis	UMa	4033
Al Gieba	Leo	4057
Algeiba	Leo	4057
ALGIEBA	Leo	4057
El Phekrah	UMa	4069
Tania Australis	UMa	4069
Praecipua	LMi	4247
Alkes	Crt	4287
MERAK	UMa	4295
Mirak	UMa	4295
Ak	UMa	4301
Dubb	UMa	4301
DUBHE	UMa	4301
Dhur	Leo	4357
Duhr	Leo	4357
Zosca	Leo	4357
Zosma	Leo	4357
Zozca	Leo	4357
Zozma	Leo	4357

Proper name of the star in the Bright Star Catalogue (BS4, BS5) [1197]	*Star containing constellation*	*Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]*
Zubra	Leo	4357
Chenan	Leo	4359
Chort	Leo	4359
Coxa	Leo	4359
Alula Australis	UMa	4375
El Acola	UMa	4375
Alula Borealis	UMa	4377
Gianfar	Dra	4434
Giansar	Dra	4434
Giausar	Dra	4434
Giauzar	Dra	4434
Juza	Dra	4434
Al Kaphrah	UMa	4518
Alkaphrah	UMa	4518
El Koprah	UMa	4518
Deneb	Leo	4534
Deneb Aleet	Leo	4534
DENEBOLA	Leo	4534
Alaraph	Vir	4540
Minelauva	Vir	4540
Zarijan	Vir	4540
Zavijah	Vir	4540
Zavijava	Vir	4540
Zavyava	Vir	4540
Zawijah	Vir	4540
Phacd	UMa	4554
PHAD	UMa	4554
Phecda	UMa	4554
Phegda	UMa	4554
Phekda	UMa	4554
Phekha	UMa	4554
Al Chiba	Crv	4623
Al Minliar al Ghurab	Crv	4623
Alchiba	Crv	4623
Alchita	Crv	4623
Alkhiba	Crv	4623
Minkar	Crv	4630
Kaffa	UMa	4660

Proper name of the star in the Bright Star Catalogue (BS4, BS5) [1197]	*Star containing constellation*	*Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]*
Megrcs	UMa	4660
MEGREZ	UMa	4660
Gienah	Crv	4662
Gienah Ghurab	Crv	4662
Zaniah	Vir	4689
ACRUX	Cru	4730
Algorab	Crv	4757
Algoral	Crv	4757
Algorel	Crv	4757
Algores	Crv	4757
Gacrux	Cru	4763
Chara	CVn	4785
Kraz	Crv	4786
Arich	Vir	4825
Porrima	Vir	4825
Superba	CVn	4846
Becrux	Cru	4853
Mimosa	Cru	4853
Aliath	UMa	4905
ALIOTH	UMa	4905
Auva	Vir	4910
Minelauva	Vir	4910
COR CAROLI	CVn	4915
Alaraph	Vir	4932
Almuredin	Vir	4932
Protrygetor	Vir	4932
Vendemiatrix	Vir	4932
Vindemiator	Vir	4932
VINDEMIATRIX	Vir	4932
La Superba	CVn	4945
Diadem	Corn	4968
Mirza	UMa	5054
MIZAR	UMa	5054
Mizat	UMa	5054
Alaraph	Vir	5056
Azimech	Vir	5056
SPICA	Vir	5056
Spica Virginis	Vir	5056

Proper name of the star in the Bright Star Catalogue (BS4, BS5) [1197]	*Star containing constellation*	*Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]*
ALCOR	UMa	5062
Saidak	UMa	5062
Suha	UMa	5062
Heze	Vir	5107
ALKAID	UMa	5191
Benatnasch	UMa	5191
Benetnasch	UMa	5191
Benetnash	UMa	5191
Elkeid	UMa	5191
Mufrid	Boo	5235
Mufride	Boo	5235
Muphrid	Boo	5235
Muphridc	Boo	5235
AGENA	Cen	5267
HADAR	Cen	5267
Menkent	Cen	5288
Adib	Dra	5291
Al Tinnin	Dra	5291
Dragon's Tail	Dra	5291
THUBAN	Dra	5291
Asellus Tertius	Boo	5329
Syrma	Vir	5338
ARCTURUS	Boo	5340
Job's Star	Boo	5340
Asellus Secundus	Boo	5350
Asellus Primus	Boo	5404
Ceginus	Boo	5435
Haris	Boo	5435
Seginus	Boo	5435
Rigel Kent	Cen	5459
Rigel Kentaurus	Cen	5459
RIGIL KENT	Cen	5459
Rigil Kentaurus	Cen	5459
Toliman	Cen	5459
Tolimann	Cen	5459
Riji al Awwa	Vir	5487
IZAR	Boo	5506
Mirac	Boo	5506

Proper name of the star in the Bright Star Catalogue (BS4, BS5) [1197]	*Star containing constellation*	*Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]*
Mirach	Boo	5506
Mirak	Boo	5506
Mizar	Boo	5506
Pulcherrima	Boo	5506
Elkhiffa Australis	Lib	5531
Kiffa Australis	Lib	5531
Zuben el Genubi	Lib	5531
Zuben Elgenubi	Lib	5531
Zubenelgenubi	Lib	5531
Falx Italica	Boo	5533
Marrha	Boo	5533
Merga	Boo	5533
KOCAB	UMi	5563
Kochab	UMi	5563
Kochah	UMi	5563
Zuben Elakribi	Lib	5586
Meres	Boo	5602
Merez	Boo	5602
Nekkar	Boo	5602
Brachium	Sco	5603
Cornu	Sco	5603
Zuben el Genubi	Sco	5603
Zuben Elgenubi	Sco	5603
Zuben Hakrabi	Sco	5603
Zuben Hakrabi	Lib	5622
Elkhiffa Borealis	Lib	5685
Kiffa Borealis	Lib	5685
Zubcneschamali	Lib	5685
Zuben el Chamali	Lib	5685
Zuben Elschemali	Lib	5685
Zubeneig	Lib	5685
Zubenesch	Lib	5685
Pherkad Minor	UMi	5714
Zuben Hakrabi	Lib	5723
Alkalurops	Boo	5733
Clava	Boo	5733
Icalurus	Boo	5733
Inkalunis	Boo	5733

Proper name of the star in the Bright Star Catalogue (BS4, BS5) [1197]	*Star containing constellation*	*Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]*
Venabulum	Boo	5733
Pherkad	UMi	5735
Pherkad Major	UMi	5735
Al Dhiba	Dra	5744
Al Dhihi	Dra	5744
Ed Asich	Dra	5744
Eldsich	Dra	5744
Nusakan	CrB	5747
Zuben el Hakrabi	Lib	5787
Zuben Elakrab	Lib	5787
Zuben Hakraki	Lib	5787
Zubenhakrabi	Lib	5787
Alphaca	CrB	5793
Alphacca	CrB	5793
Alphecca	CrB	5793
ALPHEKKA	CrB	5793
Ashtaroth	CrB	5793
Gemma	CrB	5793
Gnosia	CrB	5793
Gnosia Stella Coronae	CrB	5793
Jewel	CrB	5793
Cor Serpentis	Scr	5854
Unuk	Ser	5854
Unuk al Hay	Ser	5854
Unuk Elhaia	Ser	5854
UNUKALHAI	Ser	5854
Unukalhay	Ser	5854
Variabilis Coronae	CrB	5880
Dschubba	Sco	5953
Iclarkrau	Sco	5953
Acrab	Sco	5984
Akrab	Sco	5984
Elacrab	Sco	5984
Graffias	Sco	5984
Grafias	Sco	5984
Marfak	Her	6008
Marfic	Her	6008
Marfik	Her	6008

Proper name of the star in the Bright Star Catalogue (BS4, BS5) [1197]	*Star containing constellation*	*Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]*
Marsik	Her	6008
Mirfak	Her	6008
Jabbah	Sco	6027
Lesath	Sco	6027
Jed	Oph	6056
Yad	Oph	6056
Yed	Oph	6056
Yed Prior	Oph	6056
Yed Posterior	Oph	6075
Al Niyat	Sco	6084
Alniyat	Sco	6084
Caiam	Her	6117
Cajam	Her	6117
Cujam	Her	6117
Kajam	Her	6117
ANTARES	Sco	6134
Calbalakrab	Sco	6134
Cor Scorpii	Sco	6134
Kalb al Akrab	Sco	6134
Vespertilio	Sco	6134
Komephoros	Her	6148
Korneforos	Her	6148
Rutilicus	Her	6148
Marfic	Oph	6149
Marfik	Oph	6149
Marsic	Oph	6149
Al Niyat	Sco	6165
Al Rakis	Dra	6370
Arrakis	Dra	6370
El Rakis	Dra	6370
Er Rakis	Dra	6370
Errakis	Dra	6370
Sabik	Oph	6378
Al Dibah	Dra	6396
Aldhibah	Dra	6396
Nodus I	Dra	6396
Ras Algethi	Her	6406
Rasalegti	Her	6406

Proper name of the star in the Bright Star Catalogue (BS4, BS5) [1197]	*Star containing constellation*	*Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]*
RASALGETHI	Her	6406
Sarin	Her	6410
Lesath	Sco	6508
Leschath	Sco	6508
Lesuth	Sco	6508
Maasym	Her	6526
Masym	Her	6526
Misam	Her	6526
Alascha	Sco	6527
Lesath	Sco	6527
Lesuth	Sco	6527
SHAULA	Sco	6527
Alwaid	Dra	6536
Asuia	Dra	6536
Rastaban	Dra	6536
Rastaben	Dra	6536
Sargas	Sco	6553
Kuma	Dra	6555
Ras Alhagua	Oph	6556
Ras Alhague	Oph	6556
RASALHAGUE	Oph	6556
Ras-al-hague	Oph	6556
Cebalrai	Oph	6603
Celb-al-Rai	Oph	6603
Chclcb	Oph	6603
Kalb al Rai	Oph	6603
Kalbalrai	Oph	6603
Kelb Alrai	Oph	6603
Kelb-al-Rai	Oph	6603
Dsiban	Dra	6636
Dziban	Dra	6636
Genam	Dra	6688
Grumium	Dra	6688
Eltanin	Dra	6705
ETAMIN	Dra	6705
Etanin	Dra	6705
Ettanin	Dra	6705
Rasaben	Dra	6705

Proper name of the star in the Bright Star Catalogue (BS4, BS5) [1197]	*Star containing constellation*	*Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]*
Rastaban	Dra	6705
Zenith Star	Dra	6705
Al Nasi	Sgr	6746
Alnasl	Sgr	6746
Alwazi	Sgr	6746
Nash	Sgr	6746
Nushaba	Sgr	6746
Zujj al Nushshabah	Sgr	6746
Gildun	UMi	6789
Pherkard	UMi	6789
Vildiur	UMi	6789
Yildun	UMi	6789
Yilduz	UMi	6789
El Karidab	Sgr	6859
Kaus Media	Sgr	6859
Kaus Meridionalis	Sgr	6859
Media	Sgr	6859
KAUS AUSTRALIS	Sgr	6879
Al Athfar	Lyr	6903
Aladfar	Lyr	6903
Alathfar	Lyr	6903
Kaus Borealis	Sgr	6913
Fidis	Lyr	7001
Harp Star	Leo	7001
VEGA	Lyr	7001
Wega	Lyr	7001
SHELIAK	Lyr	7106
Shelyak	Lyr	7106
Shiliak	Lyr	7106
Ain al Rami	Sgr	7116
NUNKI	Sgr	7121
Sadira	Sgr	7121
Alga	Ser	7141
Alya	Ser	7141
Deneb	Aql	7176
Deneb el Okab	Aql	7176
Jugum	Lyr	7178
Sulafat	Lyr	7178

Proper name of the star in the Bright Star Catalogue (BS4, BS5) [1197]	*Star containing constellation*	*Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]*
Sulaphat	Lyr	7178
Ascella	Sgr	7194
Polaris Australis	Oct	7228
Deneb	Aql	7235
Deneb el Okab	Aql	7235
Alfecca	Cra	7254
Meridiana	Cra	7254
Al Baldah	Sgr	7264
Albaldah	Sgr	7264
Aladfar	Lyr	7298
Aldib	Dra	7310
Altais	Dra	7310
Nodus II	Dra	7310
Arkab Prior	Sgr	7337
Urkab Prior	Sgr	7337
Arkab Posterior	Sgr	7343
Urkab Posterior	Sgr	7343
Alrami	Sgr	7348
Ruchbah ur Ramih	Sgr	7348
Rukbat	Sgr	7348
Rukbat al Rami	Sgr	7348
Anser	Vul	7405
Albereo	Cyg	7417
ALBIREO	Cyg	7417
Alsafi	Dra	7462
Althafi	Dra	7462
Athafi	Dra	7462
Athafiyy	Dra	7462
Alsahm	Sge	7479
Sham	Sge	7479
Reda	Aql	7525
Tarazad	Aql	7525
TARAZED	Aql	7525
ALTAIR	Aql	7557
Atair	Aql	7557
Tyl	Dra	7582
Alschain	Aql	7602
Alschairn	Aql	7602

Proper name of the star in the Bright Star Catalogue (BS4, BS5) [1197]	*Star containing constellation*	*Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]*
ALSHAIN	Aql	7602
Tcrebellum	Sgr	7604
Algedi Prima	Cap	7747
Algiedi	Cap	7747
Giedi Prima	Cap	7747
Prima Giedi	Cap	7747
Algedi Secunda	Cap	7754
Giedi Secunda	Cap	7754
Gredi	Cap	7754
Gredi	Cap	7754
Secunda Giedi	Cap	7754
Alshat	Cap	7773
Dabih Minor	Cap	7775
Dabih	Cap	7776
Dabih Major	Cap	7776
Dhabih	Cap	7776
Peacock	Pav	7790
Sadir	Cyg	7796
Sador	Cyg	7796
Sadr	Cyg	7796
Sadr el dedschadsche	Cyg	7796
Al Rukbah al Dajajah	Cyg	7851
Ruchba	Cyg	7851
Rukbat al-dejajah	Cyg	7851
Deneb	Del	7852
Deneb Dulfim	Del	7852
Deneb el Delphinus	Del	7852
Rotanen	Del	7882
Rotanev	Del	7882
Venator	Del	7882
Nicolaus	Del	7906
Scalovin	Del	7906
Sualocin	Del	7906
Svalocin	Del	7906
Arided	Cyg	7924
Aridif	Cyg	7924
Arrioph	Cyg	7924
DENEB	Cyg	7924

Proper name of the star in the Bright Star Catalogue (BS4, BS5) [1197]	*Star containing constellation*	*Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]*
Deneb Cygni	Cyg	7924
Deneb el Adige	Cyg	7924
Gallina	Cyg	7924
Gienah	Cyg	7949
Gienah Cygni	Cyg	7949
Al Bali	Aqr	7950
Albali	Aqr	7950
Kitalpha	Equ	8131
Kitalphar	Equ	8131
Kitel Phard	Equ	8131
Alderaimin	Cep	8162
ALDERAMIN	Cep	8162
Saad el Sund	Aqr	8232
Sad es Saud	Aqr	8232
Sadal Suud	Aqr	8232
Sadalsud	Aqr	8232
Sadalsund	Aqr	8232
Sadalsuud	Aqr	8232
Alfirk	Cep	8238
Alphirk	Cep	8238
Bunda	Agr	8264
Nashira	Cap	8278
Azelfafage	Cyg	8301
Al Anf	Peg	8308
Alanf	Peg	8308
Enf	Peg	8308
ENIF	Peg	8308
Eniph	Peg	8308
Enir	Peg	8308
Fom	Peg	8308
Os Pegasi	Peg	8308
Erakis	Cep	8316
Garnet Star	Cep	8316
Deneb Algedi	Cap	8322
Deneb Algiedi	Cap	8322
Scheddi	Cap	8322
Sheddi	Cap	8322
El Melik	Aqr	8414

Proper name of the star in the Bright Star Catalogue (BS4, BS5) [1197]	*Star containing constellation*	*Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]*
Saad el Melik	Aqr	8414
Sadal Melik	Aqr	8414
Sadalmeiek	Aqr	8414
SADALMELIK	Aqr	8414
Sad-al-melik	Aqr	8414
Sadlamulk	Aqr	8414
Al Kirdah	Cep	8417
Alkurhah	Cep	8417
Kurhah	Cep	8417
Al Nair	Gru	8425
ALNAIR	Gru	8425
Baham	Peg	8450
Biham	Peg	8450
Ancha	Aqr	8499
Sadachbia	Aqr	8518
Sadalachbia	Aqr	8518
Al Kalb al Rai	Cep	8591
Situla	Aqr	8610
Al Hammam	Peg	8634
Homam	Peg	8634
Homan	Peg	8634
Humam	Peg	8634
Matar	Peg	8650
Sadalbari	Peg	8684
Scheat	Aqr	8709
Sheat	Aqr	8709
Skat	Aqr	8709
Difda al Auwel	PsA	8728
First Frog	PsA	8728
FOMALHAUT	PsA	8728
Hastorang	PsA	8728
Os Piscis Meridiani	PsA	8728
Os Piscis Notii	PsA	8728
Fum Al Samakah	Psc	8773
Menkib	Peg	8775
SCHEAT	Peg	8775
Seat Alpheras	Peg	8775
Sheat	Peg	8775

Proper name of the star in the Bright Star Catalogue (BS4, BS5) [1197]	*Star containing constellation*	*Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]*
Marchab	Peg	8781
MARKAB	Peg	8781
El Khereb	Peg	8880
El-Khereb	Peg	8880
Kerb	Peg	8880
Markab	Peg	8880
Markeb	Peg	8880

Proper name of the star in the Bright Star Catalogue (BS4, BS5) [1197]	*Star containing constellation*	*Number of the star in the Bright Star Catalogue (BS4, BS5) [1197]*
Salm	Peg	8880
Alrai	Cep	8974
Arrai	Cep	8974
Er Rai	Cep	8974
Errai	Cep	8974
Misam	Per	

Table 4.4 (a). The list of the stars from celestial areas A, Zod A, B, Zod B and M whose proper movement speed equals 0.1 sec per annum by one of the coordinates of the equatorial system (1900 epoch) at least, which can be identified in the Almagest reliably.

Number of the star in the catalogue [1197]	*Name of the star*	*Direct ascention α_{1900} according to [1197]*			*Declination δ_{1900} according to [1197]*			*Luminosity according to [1197]*
		h	m	s	°	′	″	
5340	16ALP BOO Arcturus	14	11	06.0	+19	42	11	–0.04
1708	13ALP AUR Capella	05	09	18.0	+45	53	47	0.08
3982	32ALP LEO Regul	10	03	02.8	+12	27	22	1.35
2943	10ALP CMI Procyon	07	34	04.0	+05	28	53	0.38
5056	67ALP VIR Spica	13	19	55.4	–10	38	22	0.98
6134	21ALP SCO Antares	16	23	16.4	–26	12	36	0.96
7001	3ALP LYR Lyra = Vega	18	33	33.1	+38	41	26	0.03
3449	43GAM CNC Aselli	08	37	29.9	+21	49	42	4.66
15	21Alp And	00	03	13.0	+28	32	18	2.06
21	11Bet Cas	00	03	50.2	+58	35	54	2.27
219	24Eta Cas	00	43	03.0	+57	17	06	3.44
337	43Bet And	01	04	07.8	+35	05	26	2.06
403	37Del Cas	01	19	16.1	+59	42	56	2.68
544	2Alp Tri	01	47	22.7	+29	05	30	3.41
545	5Gam1Ari	01	48	02.4	+18	48	21	4.83
553	6Bet Ari	01	49	06.8	+20	19	09	2.64
941	27Kap Per	03	02	44.8	+44	28	43	3.80
951	57Del Ari	03	05	54.5	+19	20	55	4.35
1346	54Gam Tau	04	14	06.0	+15	23	11	3.65
1409	74Eps Tau	04	22	46.5	+18	57	31	3.53
1457	87Alp Tau	04	30	10.9	+16	18	30	0.85
1791	112Bet Tau	05	19	58.1	+28	31	23	1.65
2821	60Iot Gem	07	19	30.9	+27	59	49	3.79
2990	78Bet Gem	07	39	11.8	+28	16	04	1.14
3323	1Omi UMa	08	21	57.5	+61	03	09	3.36
3461	47Del Cnc	08	39	00.1	+18	31	19	3.94
3569	9Iot UMa	08	52	21.8	+48	26	04	3.14
3852	14Omi Leo	09	35	48.8	+10	20	50	3.52
3905	24Mu Leo	09	47	04.6	+26	28	41	3.88
4033	33Lam UMa	10	11	04.0	+43	24	50	3.45
4301	50Alp UMa	10	57	33.6	+62	17	27	1.79
4357	68Del Leo	11	08	47.4	+21	04	18	2.56
4534	94Bet Leo	11	43	57.5	+15	07	52	2.14
4660	69Del UMa	12	10	28.7	+57	35	18	3.31
4785	8Bet CVn	12	28	59.6	+41	54	03	4.26
4825	29Gam Vir	12	36	35.5	–00	54	03	3.68

Table 4.4 (b). The list of the stars from celestial areas A, Zod A, B, Zod B and M whose proper movement speed equals 0.1 sec per annum by one of the coordinates of the equatorial system (1900 epoch) at least, which can be identified in the Almagest reliably.

Number of the star in [1197]	Name of the star	Velocity component ν_α by [1197], 0.001" annual	Velocity component ν_δ by [1197], 0.001" annual	IN THE ALMAGEST CATALOGUE			
				Bailey's number	Longitude ° ′	Latitude ° ′	Magnitude
5340	16ALP BOO	–1.098	–1.999	110	177 00	+31 30	1
1708	13ALP AUR	+0.080	–0.423	222	55 00	+22 30	1
3982	32ALP LEO	–0.249	+0.003	469	122 30	0 10	1
2943	10ALP CMI	–0.706	–1.029	848	89 10	–16 10	1
5056	67ALP VIR	–0.043	–0.033	510	176 40	–2 0	1
6134	21ALP SCO	–0.007	–0.023	553	222 40	–4 0	2
7001	3ALP LYR	+0.200	+0.285	149	257 20	62 0	1
3449	43GAM CNC	–0.103	–0.043	452	100 20	2 40	4–3
15	21Alp And	+0.137	–0.158	315	347 50	+26 00	2–3
21	11Bet Cas	+0.526	–0.177	189	7 50	+51 40	3
219	24Eta Cas	+1.101	–0.521	180	13 00	+47 50	4
337	43Bet And	+0.179	–0.109	346	3 50	+26 20	3
403	37Del Cas	+0.300	–0.045	182	20 40	+45 30	3
544	2Alp Tri	+0.010	–0.229	358	11 00	+16 30	3
545	5Gam1Ari	+0.078	–0.108	362	6 40	+7 20	3–4
553	6Bet Ari	+0.097	–0.108	363	7 40	+8 20	3
941	27Kap Per	+0.178	–0.153	201	30 30	+27 00	4
951	57Del Ari	+0.151	–0.007	369	23 50	+1 40	4
1346	54Gam Tau	+0.116	–0.024	390	39 00	–5 45	3–4
1409	74Eps Tau	+0.108	–0.036	394	41 50	–3 00	3–4
1457	87Alp Tau	+0.065	–0.189	393	42 40	–5 10	1
1791	112Bet Tau	+0.025	–0.175	400	55 40	+5 00	3
2821	60Iot Gem	–0.121	–0.088	428	82 00	+5 30	4
2990	78Bet Gem	–0.627	–0.051	425	86 40	+6 15	2
3323	1Omi UMa	–0.131	–0.110	9	85 20	+39 50	4
3461	47Del Cnc	–0.017	–0.233	453	101 20	–0 10	4–3
3569	9Iot UMa	–0.443	–0.235	20	95 30	+29 20	3
3852	14Omi Leo	–0.143	–0.041	474	117 20	–4 10	4
3905	24Mu Leo	–0.215	–0.060	464	114 20	+12 00	3
4033	33Lam UMa	–0.165	–0.043	28	112 40	+29 20	3
4301	50Alp UMa	–0.118	–0.071	24	107 40	+49 00	2
4357	68Del Leo	+0.143	–0.135	481	134 10	+13 40	2–3
4534	94Bet Leo	–0.497	–0.119	488	144 30	+11 50	1–2
4660	69Del UMa	+0.102	+0.004	26	123 10	+51 00	3
4785	8Bet CVn	–0.707	+0.288	37	140 10	+41 20	5
4825	29Gam Vir	–0.568	+0.008	503	163 10	+2 50	3

Number of the star in the catalogue [1197]	*Name of the star*	*Direct ascention α_{1900} according to [1197]*			*Declination δ_{1900} according to [1197]*			*Luminosity according to [1197]*
		h	m	s	°	′	″	
4905	77Eps UMa	12	49	37.8	+56	30	09	1.77
5107	79Zet Vir	13	29	35.8	–00	05	05	3.37
5191	85Eta UMa	13	43	36.0	+49	48	45	1.86
5235	8Eta Boo	13	49	55.3	+18	53	56	2.68
5350	21Iot Boo	14	12	37.4	+51	49	42	4.75
5404	23The Boo	14	21	47.5	+52	18	47	4.05
5435	27Gam Boo	14	28	03.0	+38	44	44	3.03
5487	107Mu Vir	14	37	47.3	–05	13	25	3.88
5531	9Alp2Lib	14	45	20.7	–15	37	34	2.75
5747	3Bet CrB	15	23	42.3	+29	27	01	3.68
5793	5Alp CrB	15	30	27.2	+27	03	04	2.23
5854	24Alp Ser	15	39	20.5	+06	44	25	2.65
6056	1Del Oph	16	09	06.2	–03	26	13	2.74
6241	26Eps Sco	16	43	41.1	–34	06	42	2.29
6410	65Del Her	17	10	55.4	+24	57	25	3.14
6556	55Alp Oph	17	30	17.5	+12	37	58	2.08
6603	60Bet Oph	17	38	31.9	+04	36	32	2.77
6879	20Eps Sgr	18	17	32.0	–34	25	55	1.85
7557	53Alp Aql	19	45	54.2	+08	36	15	0.77
7602	60Bet Aql	19	50	24.0	+06	09	25	3.71
7882	6Bet Del	20	32	51.5	+14	14	50	3.63
7949	53Eps Cyg	20	42	09.8	+33	35	44	2.46
8162	5Alp Cep	21	16	11.5	+62	09	43	2.44
8264	23Xi Aqr	21	32	25.7	–08	18	10	4.69
8278	40Gam Cap	21	34	33.1	–17	06	51	3.68
8322	49Del Cap	21	41	31.3	–16	34	52	2.87
8417	17Xi Cep	22	00	53.7	+64	08	26	4.29
8499	43The Aqr	22	11	33.4	–08	16	53	4.16
8518	48Gam Aqr	22	16	29.5	–01	53	29	3.84
8684	48Mu Peg	22	45	10.5	+24	04	25	3.48
8775	53Bet Peg	22	58	55.5	+27	32	25	2.42
8974	35Gam Cep	23	35	14.3	+77	04	27	3.21

Number of the star in [1197]	Name of the star	Velocity component ν_α by [1197], 0.001" annual	Velocity component ν_δ by [1197], 0.001" annual	IN THE ALMAGEST CATALOGUE			
				Bailey's number	Longitude ° ′	Latitude ° ′	Magnitude
4905	77Eps UMa	+0.109	–0.010	33	132 10	+53 30	2
5107	79Zet Vir	–0.286	+0.036	511	174 50	+8 40	3
5191	85Eta UMa	–0.124	–0.014	35	149 50	+54 00	2
5235	8Eta Boo	–0.064	–0.363	107	171 20	+28 00	3
5350	21Iot Boo	–0.154	+0.088	89	154 10	+58 20	5
5404	23The Boo	–0.242	–0.400	90	155 20	+60 10	5
5435	27Gam Boo	–0.116	+0.149	92	169 40	+49 00	3
5487	107Mu Vir	+0.105	–0.321	522	192 40	+9 50	4
5531	9Alp2Lib	–0.108	–0.071	529	198 00	+0 40	2
5747	3Bet CrB	–0.179	+0.083	112	191 40	+46 30	4–3
5793	5Alp CrB	+0.120	–0.091	111	194 40	+44 30	2–1
5854	24Alp Ser	+0.136	+0.044	271	204 20	+25 20	3
6056	1Del Oph	–0.048	–0.145	240	215 00	+17 00	3
6241	26Eps Sco	–0.610	–0.255	557	228 30	–11 00	3
6410	65Del Her	–0.023	–0.157	123	226 40	+48 00	3
6556	55Alp Oph	+0.117	–0.227	234	234 50	+36 00	3–2
6603	60Bet Oph	–0.042	+0.159	235	238 00	+27 15	4–3
6879	20Eps Sgr	–0.032	–0.125	572	248 00	–10 50	3
7557	53Alp Aql	+0.537	+0.387	288	273 50	+29 10	1–2
7602	60Bet Aql	+0.048	–0.482	287	274 50	+27 10	3
7882	6Bet Del	+0.112	–0.031	304	288 30	+32 00	3–4
7949	53Eps Cyg	+0.355	+0.329	168	300 50	+49 30	3
8162	5Alp Cep	+0.150	+0.052	78	346 40	+69 00	3
8264	23Xi Aqr	+0.113	–0.023	633	297 20	+6 15	5
8278	40Gam Cap	+0.188	–0.022	623	294 50	–2 10	3
8322	49Del Cap	+0.262	–0.294	624	296 20	–2 00	3
8417	17Xi Cep	+0.208	+0.089	81	358 30	+65 30	5
8499	43The Aqr	+0.117	–0.019	641	306 10	+3 00	4
8518	48Gam Aqr	+0.129	+0.012	637	309 30	+8 45	3
8684	48Mu Peg	+0.148	–0.036	324	327 00	+29 30	4
8775	53Bet Peg	+0.188	+0.142	317	332 10	+31 00	2–3
8974	35Gam Cep	–0.065	+0.156	76	33 00	+64 15	4

Notes to table 4.4.

In the initial stage of our selection we have chosen the stars for Table 4.4 that have a minimal per annum speed of 0.1 second by one of the coordinates in the equatorial system of epoch 1900 at least as listed in catalogue BS5 according to catalogue BS4 ([1197]). In the second stage we just left the stars that have a "Bayer's letter", a "Flamsteed's number", or both in their name. The point is that it was Bayer and Flamsteed who had introduced the new stellar indications, basing their research on the old tradition to a large extent, which became reflected in their new indications. The subsequent generations of astronomers already learned by the new identifications made by Bayer and Flamsteed, and the old tradition fell into oblivion as useless. In the third stage, the only stars that remained were the ones that had possessed old names of their own. Names make identifications of stars more reliable. The only stars that made it to the fourth stage were the ones located in the celestial areas measured well by Ptolemy. In the fifth and last stage the only stars that had remained were the ones that can be unambiguously identified by their Ptolemaic coordinates, even with discrepancies of 2 or 3 degrees. We would meticulously check the descriptions of luminosity indicated in the Almagest, as well as the correctness of the stellar positions in Ptolemaic descriptions. Stars became rejected if any discrepancies were found.

A detailed description of the selection procedure can be seen in Chapter 4.

As a result, 68 stars of the initial list remained; those comprise table 4.4.

ANNEX 2

The computer program of the geometrical method of dating of star configurations by their proper movement taking into account the systematic errors of the catalogue

```
{\small \tt
=====================================
program perebor; \{written in Pascal under Delphi4.0\}
uses Math;
const
   nstar1 = 300; \{limit of the number of stars in the configuration \}
   pi = 3.1415926536;     \{value $\pi$\}
   deltaGM = 5; \{ scope of search gamma around $\gamma_{stat}$ in search of optimum turn
                (in minutes of arc)\}
   deltaBM = 30; \{ scope of search beta around zero in search of optimum turn (in minutes)\}
   gstepM = 1.0; \{step of search of optimum point on gamma (in minutes)\}
   bstepM = 1.0; \{step of search of optimum point on beta (in minutes)\}
   eps = 30; \{vicinity of capture for the count of stars close by their latitude(in minutes)\}
   d8 = 900000; \{maximum distance allowed from the star to the closest one of the 8 named stars \}
type
   cr1=record
      nb                                    : integer;
      a,d,va,vd,l,b,cb,sb,Mbs5,Malm         : real;
      obozn                                 : string;
      end;
var
   co                             : array[1..nstar1] of cr1;
   ah,am,asec,dg,dm,ds,va,vd,lg,lm,bg,bm,e,ce,se,
   lx,clx,slx,bx,cbx,sbx,ly,cly,sly,by,cby,sby,
   e1,se1,ce1,ft,ps,mg,maxb1,maxb2,angle,cangle,sangle,
   x,y,gr,delt1,ymin,ymax,gstep,bstep,cgstep,
   sgstep,cbstep,sbstep,bmax,gamma0,beta0,dl0,dist0,
   cminmax,cc,fmax,fminmax,fx,y1,dist1,dBm,dBmm,
   deltaG,cdeltaG,sdeltaG,deltaB,cdeltaB,sdeltaB,
   cGstat,sGstat,xd1,xd2,d8rad,epsrad                        : real;
   stt,stm,stf             : array [1..nstar1,1..6] of real;
   Gstat         : array [1..30] of real; \{value $\gamma_{stat}$ calculated with statistics estimate
                                      procedure \}
   zv,zvv        : array [1..nstar1] of integer;
   id            : array [1..nstar1] of integer; \{attribute of keeping the star due the proximity
                                            to the 8-stars kernel:
0 - strike, 1 - keep\}
   agamt,cgamt,sgamt,abett,cbett,sbett       : real;
   nb,i,j,t,t1,t2,nstar,Ngamma,Nbeta,Ng0,Nb0,ig,ib,Nstep,
```

```
   Iok,Itek,NBmm,NBm,jj,jj1,i8                             : integer;
   f,f1,f2               : text;
   konec                          : char;
\{*********************************************************\}
\{*                                vvod                       *\}
\{*********************************************************\}
procedure vvod;
var    i                   : integer;
       Mbs5,Malm           : real;
       ob                  : string;
begin
assign(f1,'result.txt');
rewrite(f1);
assign(f2,'sig-max.txt');
rewrite(f2);
writeln(f1,'       *** Program perebor.pas ***');
writeln('      *** Program perebor.pas ***');
assign(f,'fast.txt'); \{fast.txt - Input file with stars \}
reset(f);
\{*********** reading data **************\}
nstar:=0;
while not eof(f) do
   begin \{while\}
   nstar:= nstar+1;
   i:=nstar;
   readln(f,nb,ah,am,asec,dg,dm,ds,Mbs5,va,vd,lg,lm,bg,bm,Malm,ob);
           \{++++++ structure of the data line in file fast.txt ++++++++\}
           \{ nb - number of star in BS5,                                              \}
           \{ ah - direct ascension (hours),                                           \}
           \{ am - direct ascension (minutes of the hour) NO SIGN,                    \}
           \{ asec - direct ascension (seconds of the hour) NO SIGN,           \}
           \{ dg - declination (degrees),                                              \}
           \{ dm - declination (minutes of arc), NO SIGN                              \}
           \{ ds - declination (secondes of arc), NO SIGN                             \}
           \{ va - speed of proper movement in the direct ascension,          \}
           \{    aligned to equator ("/year),                                         \}
           \{ vd - speed of proper movement in declination                    \}
           \{     ("/year),                                                           \}
           \{ lg - longitude in Almagest (degrees),                           \}
           \{ lm - longitude in Almagest (minutes), NONNEGATIVE                       \}
           \{ bg - latitude in Almagest (degrees),                                    \}
           \{ bm - latitude in Almagest (minutes)    NO SIGN                          \}
           \{ Mbs5 - magnitude (luminosity)in BS5                                     \}
           \{ Malm - magnitude (luminosity)in Almagest                                \}
           \{ ob - modern name (definition) of the star                               \}
   if (ah<0) then
             begin
             am:= -am;
             asec:=-asec;
             end;
    if (dg<0) then
             begin
             dm:= -dm;
             ds:=- ds;
             end;
    if (bg<0) then bm:= -bm;
   co[i].nb:=nb;
   co[i].a:=pi*(ah+am/60+asec/3600)/12;
   co[i].d:=pi*(dg+dm/60+ds/3600)/180;
   co[i].va:=va*pi/6480.0; \{translation of the speeds of proper movement: \}
   co[i].vd:=vd*pi/6480.0; \{seconds/year->radians/100years              \}
   co[i].l:=pi*(lg+lm/60)/180;
   co[i].b:=pi*(bg+bm/60)/180;
   co[i].Malm:=Malm;
   co[i].Mbs5:=Mbs5;
   co[i].obozn:=ob;
   co[i].cb:=cos(co[i].b);
```

```
   co[i].sb:=sin(co[i].b);
   if co[i].cb <> 0 then
       co[i].va:=co[i].va/co[i].cb;\{from now on the speed is NOT aligned to the equator \}
   writeln(f1,nb:4,' ',ah:4:0,' ',am:6:2,' ',
           dg:4:0,' ',dm:6:2,' ',
           lg:4:0,' ',lm:4:0,' ',bg:4:0,' ',bm:4:0,' ',
           Malm:3:1,'     ',Mbs5:3:1,'      ',ob);
   writeln(nb:4,' ',ah:4:0,' ',am:6:2,' ',
           dg:4:0,' ',dm:6:2,' ',
           lg:4:0,' ',lm:4:0,' ',bg:4:0,' ',bm:4:0,' ',
           Malm:3:1,'     ',Mbs5:3:1,'      ',ob);
   end;   \{while\}
writeln('nstar= ',nstar);
writeln(f1,'FAST.TXT:      nstar= ',nstar);
writeln(f1);
\{for i:=1 to nstar do
    writeln(f1,co[i].nb:4:0,' ',co[i].a:7:5,' ',co[i].d:7:5,
             ' ',co[i].l:7:5,' ',co[i].b:7:5);      \}
writeln('VVOD' );
end; \{vvod\}
\{**********************************************\}
\{*               TURN                         *\}
\{**********************************************\}
procedure turn;
   \{lx (clx, slx) - longitude(cos, sin) before the turn,
    bx (cbx, sbx) - latitude(cos, sin) before the turn,
    ly (cly, sly) - longitude(cos, sin) after the turn,
    by (cby, sby) - latitude(cos, sin) after the turn,
    angle (cangle,sangle) - angle (cos,sin) of the turn\}
var
    c,x,y    : real;
begin \{turn\}
   sby:= -slx*cbx*sangle + sbx*cangle;
   cby:= sqrt(1 - sqr(sby));
   if sby=1 then by:= pi/2
           else by:= arctan(sby/cby);
   c:= cbx*clx;
   if c = 0 then
           begin
           if cbx*cangle+slx*sbx*sangle > 0 then     ly := lx
                                                     else     ly:=lx-pi;
           if cbx = 0 then ly:= pi/2;
           end
       else \{if c is not equal zero \}
       begin
       ly:= (slx*cbx*cangle + sbx*sangle)/c;
       ly:= arctan(ly);
       if ly < 0 then ly:= ly + pi;
       \{if ly > pi then writeln('!!!!!!!!!!');     \}
    \{---------------------------------------------\}
    \{If the star is in the circle on the sphere that has as its diameter the arc of the length of
      angle connecting the new and the old poles, then the module of the difference of its old and new
      longitude is closer to pi, than to zero. If the star is outside such a circle then the module
      difference of its longitude is closer to 0 than to pi\}
       y:=pi/2 - bx;
       x:=angle*cos(lx+pi/2); \{To facilitate calculation an estimate is used.
                               Actually: angle*cos(lx+pi/2) <= x <= angle \}
       if y>x   then
                  begin
                  if abs(abs(lx-ly)-pi)<pi/2 then ly:=ly+pi;
                  end
              else
                  begin
                  if abs(lx-ly)<pi/2 then ly:=ly+pi;
                  end;
    \{---------------------------------------------\}
       end; \{if c is not equal zero\}
```

```
   cly:= cos(ly);
   sly:= sin(ly);
   if ly > 2*pi then ly:=ly-2*pi;
   if ly < 0 then ly:=ly+2*pi;
end;   \{turn\}
\{************************************************************\}
\{*             RECALCULATION FOR MOMENT IN TIME T            *\}
\{************************************************************\}
procedure pereschet;
var i: integer;
       z,zz: real;
     \{result: stt[i,1] = l
               stt[i,2] = cos(l)
              stt[i,3] = sin(l)
              stt[i,4] = b
              stt[i,5] = cos(b)
              stt[i,6] = sin(b)
              where l,b - ecliptical coordinates of the star in epoch t
                          (taking its proper movement into account)\}
     begin \{pereschet\}
     for i:= 1 to nstar do
       begin \{for i\}
       lx := co[i].a + t1*co[i].va;
       clx:= cos(lx);
       slx:= sin(lx);
       bx := co[i].d + t1*co[i].vd;
       sbx:= sin(bx);
       cbx:= sqrt(1 - sqr(sbx));
       cangle:= ce;
       sangle:= se;
       angle:=e;
       turn;
       bx := by;
       cbx:= cby;
       sbx:= sby;
       lx:= ly - ft;
       if lx < 0 then lx:= lx + 2*pi;
       clx:= cos(lx);
       slx:= sin(lx);
       cangle:= ce1;
       sangle:= se1;
       angle:=e1;
       turn;
       stt[i,4]:= by;
       stt[i,5]:= cby;
       stt[i,6]:= sby;
       lx:= ly + ft + ps;
       if lx > 2*pi         then lx:= lx - 2*pi;
       if lx <= -2*pi then lx:= lx + 2*pi;
       if lx > 2*pi         then lx:= lx - 2*pi;
       if lx <= -2*pi then lx:= lx + 2*pi;
       stt[i,1]:= lx;
       stt[i,2]:= cos(lx);
       stt[i,3]:= sin(lx);
     \{-----------------
       zz:=mg/60;
       z:= (stt[i,1]-co[i].l)*zz;
       writeln(f1,co[i].nb:4,'      ','L= ',lx*zz:5:3,';       B= ',by*zz:5:3);
       writeln(co[i].nb:4,'         ','L= ',lx*zz:5:3,';       B= ',by*zz:5:3);
       if abs(z)> 20 then
       begin
writeln(f1,'dL=',z:10:1,'(gr); i= ',co[i].nb,' L-alm=',co[i].l*zz:6:2,
                                                            ' B-alm=',co[i].b*zz:6:2);
writeln('','dL=',z:10:1,'(gr); i= ',co[i].nb,' L-alm=',co[i].l*zz:6:2,
                                                            ' B-alm=',co[i].b*zz:6:2);
       end;
       z:= (stt[i,4]-co[i].b)*mg;
```

```
       if abs(z)> 300 then
       begin
       writeln(f1,'        ','dB= ',z:10:1,'(min);    i= ',i);
       writeln('  ','dB= ',z:10:1,'(min);    i= ',i);
       end;
       ------------------   \}
       end;   \{for i\}
end; \{pereschet\}
\{**********************************************************\}
\{*  DIST (distance between points on the sphere in radians) *\}
\{**********************************************************\}
function dist(L1:real;B1:real;L2:real;B2:real) : real;
   \{L1,B1 - longitude and latitude of the first point,
    L2,B2 - longitude and latitude of the second point \}
var
    X1,X2,Y1,Y2,Z1,Z2,DE,DSIN,DTAN           : real;
begin \{dist\}
        X1 := COS(B1)*COS(L1);
        Y1 := COS(B1)*SIN(L1);
        Z1 := SIN(B1);
        X2 := COS(B2)*COS(L2);
        Y2 := COS(B2)*SIN(L2);
        Z2 := SIN(B2);
        DE:=SQRT(SQR(X1-X2)+SQR(Y1-Y2)+SQR(Z1-Z2));
        DSIN:= DE/2;
        DTAN:=DSIN/SQRT(1.0-SQR(DSIN));
        Result:= 2.0*ARCTAN(DTAN);
end;\{dist\}
\{************************************************************\}
\{                      MAIN PROGRAM                          \}
\{************************************************************\}
begin \{program\}
\{**********************************\}
   vvod;  \{stars data input from file fast.txt\}
\{**********************************\}
   mg:= 180.0*60.0/pi;    \{ratio for recalculation from arc minutes into radians and reverse \}
   e:=pi*(23+27/60+8.26/3600)/180; \{angle of inclinitation of eclipticto equator for t=0\}
   se:=sin(e);
   ce:=cos(e);
   d8rad:=d8/mg;
   epsrad:=eps/mg;
   \{----------------------\}
      for i:=1 to n star do
      begin
      xd1:=10;
      for i8:=1 to 8 do  \{8 stars of the informative kernel must stand in the beginning!\}
         begin
         xd2:=dist(co[i8].a,co[i8].d,co[i].a,co[i].d);
    \{  writeln(f1,co[i].nb,'       dist (min) = ',xd2*mg:4:1);          \}
         if xd2 < xd1 then xd1:=xd2;
         end;
         xd2:=xd1*mg/60;
   \{  writeln(f1,co[i].nb,'        dist (grad) = ',xd2:4:1); \}
         if xd1 < d8rad then id[i]:=1 else id[i]:=0;
         end;
   \{----------------------\}
   gstep:=gstepM/mg;
   bstep:=bstepM/mg;
   cgstep:= cos(gstep);
   sgstep:= sin(gstep);
   cbstep:= cos(bstep);
   sbstep:= sin(bstep);
   deltaG:=deltaGM/mg;
   cdeltaG:= cos(deltaG);
   sdeltaG:= sin(deltaG);
   deltaB:=deltaBM/mg;
   cdeltaB:= cos(deltaB);
```

```
   sdeltaB:= sin(deltaB);
   Ngamma:=Trunc(deltaG/gstep); \{number of steps on gamma to one side\}
   Nbeta:= Trunc(deltaB/bstep);      \{ number of steps on beta to one side\}
   Gstat[1]:= 30.5/mg;
   Gstat[2]:= 29.5/mg;
   Gstat[3]:= 28.5/mg;
   Gstat[4]:= 27.5/mg;
   Gstat[5]:= 27.0/mg;
   Gstat[6]:= 26.0/mg;
   Gstat[7]:= 25.2/mg;
   Gstat[8]:= 24.4/mg;
   Gstat[9]:= 23.5/mg;
   Gstat[10]:= 22.6/mg;
   Gstat[11]:= 21.8/mg;
   Gstat[12]:= 21.0/mg;
   Gstat[13]:= 20.4/mg;
   Gstat[14]:= 19.5/mg;
   Gstat[15]:= 18.8/mg;
   Gstat[16]:= 18.0/mg;
   Gstat[17]:= 17.2/mg;
   Gstat[18]:= 16.4/mg;
   Gstat[19]:= 15.8/mg;
   Gstat[20]:= 15.0/mg;
   Gstat[21]:= 14.4/mg;
   Gstat[22]:= 13.8/mg;
   Gstat[23]:= 13.1/mg;
   Gstat[24]:= 12.5/mg;
   Gstat[25]:= 12.0/mg;
   Gstat[26]:= 11.5/mg;
   Gstat[27]:= 11.1/mg;
   Gstat[28]:= 10.8/mg;
   Gstat[29]:= 10.5/mg;
   Gstat[30]:= 10.2/mg;
    writeln(f2,' t          ','sigma          ','maxB','       N-in-eps');
   for t:=1 to 30 do \{time cycle with 1=century step\}
   begin \{for t\}
    \{ writeln(f1,'T = ',t:2);
   writeln(f1);   \}
   writeln('T = ',t:2);
   writeln;
   t1:=-t;
   e1:=(pi/648000.0)*(47.070559+(-0.033769+0.00005*t1)*t1)*t1;
   se1:=sin(e1);
   ce1:=cos(e1);
   ft:=(pi/180.0)*(174+52/60.0 -t1*870.0798/3600.0+t1*t1*0.024578/3600.0);
   ps:=(pi/648000.0)*(5026.872+(1.131358+0.000102*t1)*t1)*t1;
\{***********************************************************        \}
   pereschet;  \{recalculation of star coordinates in epoch t \}
\{***********************************************************        \}
   cGstat:=cos(Gstat[t]);
   sGstat:=sin(Gstat[t]);
   angle:= Gstat[t]-deltaG;
   cangle:= cdeltaG*cGstat+sdeltaG*sGstat;
   sangle:= sGstat*cdeltaG -sdeltaG*cGstat; \{ in the beginning current angle of turn on gamma
                                             is set Gstat[t]-deltaG \}
 \{cgamt,sgamt - cosinus and sinus of accumulated angle of turn on gamma\}
 \{cbett,sbett - cosinus and sinus of accumulated angle of turn on beta\}
   bmax:=1;    \{preparation for minimum rotation for maximum stellar latitude non-alignment\}
   dBmm:=1;    \{preparation for minimum rotation for medium stellar latitude non-alignment \}
   Nbmm:=0;   \{preparation for maximum number of stars by turns landing in eps' - vicinity of
                Almagest star \}
   gamma0:=0; \{preparation for optimum turn on gamma\}
   beta0:=0;  \{preparation for optimum turn on beta\}
   dl0:=0; \{preparation for spread on longitude with minimax on latitude \}
   dist0:=0;   \{preparation non-alignment on arc with minimax on latitude \}
   for ig:=-Ngamma to Ngamma do
   begin \{for ig - turn along\}
```

```
   \{  writeln('ig = ',ig); \}
   i:=1;
      while (i <= nstar) do
      begin \{while i<=nstar\}
      lx := stt[i,1];
      clx:= stt[i,2];
      slx:= stt[i,3];
      bx := stt[i,4];
      cbx:= stt[i,5];
      sbx:= stt[i,6];
      turn;
      if ly > 3.0*pi/2.0 then x:= ly-2.0*pi else x:=ly;
      stm[i,1]:= x+pi/2;
      stm[i,2]:= -sly;
      stm[i,3]:= cly;
      stm[i,4]:= by;
      stm[i,5]:= cby;
      stm[i,6]:= sby;
      i:=i+1;
      end; \{while i<=nstar\}
      agamt:=angle;
      cgamt:=cangle;
      sgamt:=sangle;      \{record the accumulated angle on gamma,
                           to use after a completed cycle of across turns\}
      angle:= -deltaB;
      cangle:= cdeltaB;
sangle:= -sdeltaB; \{in the beginning of the cycle of turns set the angle equal to -deltaB\}
      for ib:= -Nbeta to Nbeta do
      begin \{for ib - across turn\}
         i:=1;
         maxb1:=0.0;
         ymin:=7.0;
         ymax:=-7.0;
         dBm:=0;
         Nbm :=0;
         while (i <= nstar)       do
         begin \{while i<=nstar\}
         lx := stm[i,1];
         clx:= stm[i,2];
         slx:= stm[i,3];
         bx := stm[i,4];
         cbx:= stm[i,5];
         sbx:= stm[i,6];
         turn;
         stf[i,2]:=by;
         stf[i,3]:=cby;
         if ly < pi/2 then y:=ly + 2*pi else y:= ly;
         stf[i,1]:=ly - pi/2;
         y:= y - pi/2 - co[i].l;
         if y < -pi then y:=y+2*pi
                          else if y> pi then y:= y-2*pi;
         if y < -pi then y:= y+2*pi
                          else if y>pi then y:=y-2*pi;
         y1:=y*cby;
         if abs(y1)>0.5 then
            begin
            writeln(f1,'dL*cosB=',y1:10:5,'(rad); N(BS5)=',co[i].nb:4);
            writeln('dL*cosB=',y1:10:5,'(rad); N(BS5)=',co[i].nb:4);
            writeln(f1,'cosB=',cby:10:5);
            writeln('cosB=',cby:10:5);
            x:=mg/60;
            writeln(f1,'by=',by*x:9:2,'    ly=',ly*x:9:2);
            writeln('by=',by*x:9:2,'       ly=',ly*x:9:2);
            writeln(f1,'L-alm=',co[i].l*x:9:2,'     B-alm=',co[i].b*x:9:2);
            writeln('L-alm=',co[i].l*x:9:2,'        B-alm=',co[i].b*x:9:2);
            readln(konec);
            end;
```

```
          stf[i,4]:=y;
          if y < ymin then ymin:= y;
          if y > ymax then ymax:= y;
 \{----1-st case: kernel of 8 stars is always kept ------\}
          maxb2:= abs(by - co[i].b);
          if (id[i]=1) and (maxb2 < epsrad) then
                                  begin
                                  dBm:=dBm+sqr(maxb2);
                                  NBm:=NBm+1;
                                  zv[NBm]:=i;
                                  end;
          if maxb2 > maxb1 then
               begin
               maxb1:= maxb2;
               Itek:=i
               end;
          i:= i+1;
          end; \{while i<=nstar\}
          dBm:=sqrt(dBm/NBm);
\{-----2-nd case: the kernel is not separated when kept -----\}
     \{     maxb2:= abs(by - co[i].b);
          dBm:=dBm+sqr(maxb2);
          if maxb2*mg<eps then NBm:=NBm+1;
          if maxb2 > maxb1 then
               begin
               maxb1:= maxb2;
               Itek:=i
               end;
          i:= i+1;
          end; \{while i<=nstar\}
     \{    dBm:=sqrt(dBm/nstar);                      \}
     \{-----------end of 2 cases--------\}
          \{====================================================
          deltL:=(ymin+ymax)/2; \}\{- previous calculation of optimal twist \}
          \{Improved calculation of optimal twist on longitude:
          Look maximum on C minimum on i of value
          cos(B)*[abs(dL(i) - C],
          where B - maximum of Almagest latitude and calculated altitude,
          dL(i) - difference between calculated and Almagest longitude for i star.
          Resulting C produces the value of optimal twist deltL        \}
          x:=0.01;
          y:=ymax-ymin;
          Nstep:=Trunc(y/x);
          cminmax:=ymin;
          cc:=ymin;
          fminmax:=7;
          for i:=1 to Nstep do
             begin
             cc:=cc+x;
             fmax:=0;
             for j:=1 to nstar do
             begin
             fx:=Min(stf[j,3],co[j].cb);
             fx:=fx*abs(stf[j,4]-cc);
             if fx > fmax then fmax:=fx;
             end;
             if fmax < fminmax then
                                           begin
                                           fminmax:=fmax;
                                           deltL:=cc;
                                           end;
             end;
          \{====================================================\}
          \{if (maxb1 < bmax) then \}
          if (dBm < dBmm) then     \{ <- one of three versions is chosen \}
           \{ if (NBm > NBmm) then \}
          begin
```

```
          bmax:=maxb1;
          Iok:=Itek;
          Ng0:=ig;
          Nb0:=ib;
          dBmm:=dBm;
          NBmm:=NBm;
                 for jj:=1 to NBm do
                 begin
                 zvv[jj]:=zv[jj];
                 end;
          gr:=0.0;
          for i:=1 to nstar do
             begin
             x:= (stf[i,4]-deltL)*Min(stf[i,3],co[i].cb);
             x:= sqr(x);
             y:=sqr(stf[i,2] - co[i].b);
             x:=sqrt(x+y);
             if x > gr then gr:=x;
             end;
          dist0:=gr;
          end; \{if maxb1<bmax, if dBm < dBmm or if (NBm > NBmm)\}
          abett:=angle;
          cbett:=cangle;
          sbett:=sangle;
          angle:=angle+bstep;
          cangle:= cbett*cbstep - sbett*sbstep;
          sangle:= sbett*cbstep + cbett*sbstep;
       end;    \{for ib - turn across\}
       angle:= agamt+gstep;
       cangle:= cgamt*cgstep - sgamt*sgstep;
       sangle:= sgamt*cgstep + cgamt*sgstep;
       end; \{for ig - turn along\}
   \{*****************************************************************\}
                 \{save and print file \}
   gamma0:= (Ng0*gstep+Gstat[t])*mg;
   beta0:=Nb0*bstep*mg;
   bmax:=bmax*mg;
   dist0:=dist0*mg;
   dBmm:=dBmm*mg;
   t2:=1900-t*100;
   writeln(f1,'==================================================');
   writeln(f1,'Max distance to inf. kernel allowed = ',d8,'(min)');
   writeln(f1,'  ',t2:2,'           ',bmax:4:1,' (',co[Iok].nb:4,
   ')     ',gamma0:4:1,'            ',beta0:4:1,'              ',dist0:4:1);
 writeln(f1,'     sigma=',dBmm:4:1,' Nstars= ',NBmm,'(',eps,'min close)');
   for jj:=1 to NBmm do
        begin
        jj1:=zvv[jj];
        writeln(f1,co[jj1].nb,'      ',co[jj1].obozn);
        end;
   writeln(f2,t2:2,'        ',dBmm:4:1,'     ',bmax:4:1,'      ',NBmm);
   writeln('*** T = ',t2:2,'       ***');
   writeln('Max distance to inf. kernel allowed = ',d8,'(min)');
   writeln('dBmax=',bmax:4:1,' i=',co[Iok].nb:4,' gamma=',gamma0:4:1,
            ' beta= ',beta0:4:1,'         dist=',dist0:4:1);
 writeln('sigma=',dBmm:4:1,'; Nstars (',eps,' min close)=',NBmm);
   end;   \{for t\}
close(f1);
close(f2);
writeln('Enter any character');
readln(konec);
end.
===========================================
\vspace{1cm}
```

EXAMPLES OF INPUT FILES FOR PERESCHET PROGRAM (FAST.TXT)

```
\vspace{0.5cm}
Contents of columns in input data file FAST.TXT for PERESCHET program:
1 column - number of star in catalogues BS4, BS5;
2 column - direct ascension RA 1900 in BS5: hours;
3 column - direct ascension RA 1900 in BS5: minutes;
4 column - direct ascension RA 1900 in BS5: seconds;
5 column - declination DEC 1900 in BS5: degrees;
6 column - declination DEC 1900 in BS5: minutes;
7 column - declination DEC 1900 in BS5: seconds;
8 column - star magnitude in BS5;
9 column - speed of proper movement in RA1900, aligned to equator (in BS4);
10 column - speed of proper movement in DEC1900, aligned to equator (in BS4);
11 column - longitude in Almagest;
12 column - latitude in Almagest;
13 column - brightness in Almagest;
14 column - modern name of star in BS5.
\vspace{0.7cm}
```

1. Data file: 8 stars of informative kernel of Almagest.

```
\vspace{0.4cm}
}
{\footnotesize \tt
5340  14  11  06.0  +19  42  11  -0.04  -1.098  -1.999  177  00  +31  30 1.~ 16Alp Boo
1708  05  09  18.0  +45  53  47  ~0.08  +0.080  -0.423  ~55  00  +22  30 1.~ 13Alp Aur
3982  10  03  02.8  +12  27  22  ~1.35  -0.249  +0.003  122  30  ~~0  10 1.~ 32Alp Leo
2943  07  34  04.0  +05  28  53  ~0.38  -0.706  -1.029  ~89  10  -16  10 1.~ 10Alp CMi
5056  13  19  55.4  -10  38  22  ~0.98  -0.043  -0.033  176  40  ~~2  ~0 1.~ 67Alp Vir
6134  16  23  16.4  -26  12  36  ~0.96  -0.007  -0.023  222  40  ~~4  ~0 2.~ 21Alp Sco
7001  18  33  33.1  +38  41  26  ~0.03  +0.200  +0.285  257  20  ~62  ~0 1.~ ~3Alp Lyr
3449  08  37  29.9  +21  49  42  ~4.66  -0.103  -0.043  100  20  ~~2  40 3.7 43Gam Cnc
}
{\small \tt
\vspace{0.7cm}
```

2. Data file: named stars from A, ZodA, B, ZodB, M, are rapid (>=0.1"/year in RA1900 or DEC1900) and isolated ones among stars of comparable brightness, resulting in their unambiguous identity in Almagest catalogue. The 8 stars Almagest informative kernel is added.

```
}
\vspace{0.4cm}
{\footnotesize \tt
5340 14 11 06.0 +19 42 11  -0.04 -1.098 -1.999 177 00 +31 30 1.~  16Alp Boo
1708 05 09 18.0 +45 53 47  ~0.08 +0.080 -0.423 ~55 00 +22 30 1.~  13Alp Aur
3982 10 03 02.8 +12 27 22  ~1.35 -0.249 +0.003 122 30 ~~0 10 1.~  32Alp Leo
2943 07 34 04.0 +05 28 53  ~0.38 -0.706 -1.029 ~89 10 -16 10 1.~  10Alp CMi
5056 13 19 55.4 -10 38 22  ~0.98 -0.043 -0.033 176 40 ~~2 ~0 1.~  67Alp Vir
6134 16 23 16.4 -26 12 36  ~0.96 -0.007 -0.023 222 40 ~~4 ~0 2.~  21Alp Sco
7001 18 33 33.1 +38 41 26  ~0.03 +0.200 +0.285 257 20 ~62 ~0 1.~  ~3Alp Lyr
3449 08 37 29.9 +21 49 42  ~4.66 -0.103 -0.043 100 20 ~~2 40 3.7  43Gam Cnc
~~15 00 03 13.0 +28 32 18  ~2.06 +0.137 -0.158 347 50 +26 00 2.3  21Alp And
~~21 00 03 50.2 +58 35 54  ~2.27 +0.526 -0.177 ~~7 50 +51 40 3.~  11Bet Cas
~219 00 43 03.0 +57 17 06  ~3.44 +1.101 -0.521 ~13 00 +47 50 4.~  24Eta Cas
~337 01 04 07.8 +35 05 26  ~2.06 +0.179 -0.109 ~~3 50 +26 20 3.~  43Bet And
~403 01 19 16.1 +59 42 56  ~2.68 +0.300 -0.045 ~20 40 +45 30 3.~  37Del Cas
~544 01 47 22.7 +29 05 30  ~3.41 +0.010 -0.229 ~11 00 +16 30 3.~  ~2Alp Tri
~545 01 48 02.4 +18 48 21  ~4.83 +0.078 -0.108 ~~6 40 ~+7 20 3.3  5Gam1Ari
~553 01 49 06.8 +20 19 09  ~2.64 +0.097 -0.108 ~~7 40 ~+8 20 3.~  ~6Bet Ari
~941 03 02 44.8 +44 28 43  ~3.80 +0.178 -0.153 ~30 30 +27 00 4.~  27Kap Per
~951 03 05 54.5 +19 20 55  ~4.35 +0.151 -0.007 ~23 50 ~+1 40 4.~  57Del Ari
```

```
1346 04 14 06.0 +15 23 11  ~3.65 +0.116 -0.024 ~39 00 ~-5 45 3.3  54Gam Tau
1409 04 22 46.5 +18 57 31  ~3.53 +0.108 -0.036 ~41 50 ~-3 00 3.3  74Eps Tau
1457 04 30 10.9 +16 18 30  ~0.85 +0.065 -0.189 ~42 40 ~-5 10 1.~  87Alp Tau
1791 05 19 58.1 +28 31 23  ~1.65 +0.025 -0.175 ~55 40 ~+5 00 3.~  112Bet Tau
2821 07 19 30.9 +27 59 49  ~3.79 -0.121 -0.088 ~82 00 ~+5 30 4.~  60Iot Gem
2990 07 39 11.8 +28 16 04  ~1.14 -0.627 -0.051 ~86 40 ~+6 15 2.~  78Bet Gem
3323 08 21 57.5 +61 03 09  ~3.36 -0.131 -0.110 ~85 20 +39 50 4.~  1Omi UMa
3461 08 39 00.1 +18 31 19  ~3.94 -0.017 -0.233 101 20 ~-0 10 3.7  47Del Cnc
3569 08 52 21.8 +48 26 04  ~3.14 -0.443 -0.235 ~95 30 +29 20 3.~  ~9Iot UMa
3852 09 35 48.8 +10 20 50  ~3.52 -0.143 -0.041 117 20 ~-4 10 4.~  14Omi Leo
3905 09 47 04.6 +26 28 41  ~3.88 -0.215 -0.060 114 20 +12 00 3.~  24Mu Leo
4033 10 11 04.0 +43 24 50  ~3.45 -0.165 -0.043 112 40 +29 20 3.~  33Lam UMa
4301 10 57 33.6 +62 17 27  ~1.79 -0.118 -0.071 107 40 +49 00 2.~  50Alp UMa
4357 11 08 47.4 +21 04 18  ~2.56 +0.143 -0.135 134 10 +13 40 2.3  68Del Leo
4534 11 43 57.5 +15 07 52  ~2.14 -0.497 -0.119 144 30 +11 50 1.3  94Bet Leo
4660 12 10 28.7 +57 35 18  ~3.31 +0.102 +0.004 123 10 +51 00 3.~  69Del UMa
4785 12 28 59.6 +41 54 03  ~4.26 -0.707 +0.288 140 10 +41 20 5.~  ~8Bet CVn
4825 12 36 35.5 -00 54 03  ~3.68 -0.568 +0.008 163 10 ~+2 50 3.~  29Gam Vir
4905 12 49 37.8 +56 30 09  ~1.77 +0.109 -0.010 132 10 +53 30 2.~  77Eps UMa
5107 13 29 35.8 -00 05 05  ~3.37 -0.286 +0.036 174 50 ~+8 40 3.~  79Zet Vir
5191 13 43 36.0 +49 48 45  ~1.86 -0.124 -0.014 149 50 +54 00 2.~  85Eta UMa
5235 13 49 55.3 +18 53 56  ~2.68 -0.064 -0.363 171 20 +28 00 3.~  ~8Eta Boo
5350 14 12 37.4 +51 49 42  ~4.75 -0.154 +0.088 154 10 +58 20 5.~  21Iot Boo
5404 14 21 47.5 +52 18 47  ~4.05 -0.242 -0.400 155 20 +60 10 5.~  23The Boo
5435 14 28 03.0 +38 44 44  ~3.03 -0.116 +0.149 169 40 +49 00 3.~  27Gam Boo
5487 14 37 47.3 -05 13 25  ~3.88 +0.105 -0.321 192 40 ~+9 50 4.~  107Mu Vir
5531 14 45 20.7 -15 37 34  ~2.75 -0.108 -0.071 198 00 ~~0 40 2.~  ~9Alp2Lib
5747 15 23 42.3 +29 27 01  ~3.68 -0.179 +0.083 191 40 +46 30 3.7  ~3Bet CrB
5793 15 30 27.2 +27 03 04  ~2.23 +0.120 -0.091 194 40 +44 30 1.7  ~5Alp CrB
5854 15 39 20.5 +06 44 25  ~2.65 +0.136 +0.044 204 20 +25 20 3.~  24Alp Ser
6056 16 09 06.2 -03 26 13  ~2.74 -0.048 -0.145 215 00 +17 00 3.~  ~1Del Oph
6241 16 43 41.1 -34 06 42  ~2.29 -0.610 -0.255 228 30 -11 00 3.~  26Eps Sco
6410 17 10 55.4 +24 57 25  ~3.14 -0.023 -0.157 226 40 +48 00 3.~  65Del Her
6556 17 30 17.5 +12 37 58  ~2.08 +0.117 -0.227 234 50 +36 00 2.7  55Alp Oph
6603 17 38 31.9 +04 36 32  ~2.77 -0.042 +0.159 238 00 +27 15 3.7  60Bet Oph
6879 18 17 32.0 -34 25 55  ~1.85 -0.032 -0.125 248 00 -10 50 3.~  20Eps Sgr
7557 19 45 54.2 +08 36 15  ~0.77 +0.537 +0.387 273 50 +29 10 1.7  53Alp Aql
7602 19 50 24.0 +06 09 25  ~3.71 +0.048 -0.482 274 50 +27 10 3.~  60Bet Aql
7882 20 32 51.5 +14 14 50  ~3.63 +0.112 -0.031 288 30 +32 00 3.3  ~6Bet Del
7949 20 42 09.8 +33 35 44  ~2.46 +0.355 +0.329 300 50 +49 30 3.~  53Eps Cyg
8162 21 16 11.5 +62 09 43  ~2.44 +0.150 +0.052 346 40 +69 00 3.~  ~5Alp Cep
8264 21 32 25.7 -08 18 10  ~4.69 +0.113 -0.023 297 20 ~+6 15 5.~  23Xi Aqr
8278 21 34 33.1 -17 06 51  ~3.68 +0.188 -0.022 294 50 ~-2 10 3.~  40Gam Cap
8322 21 41 31.3 -16 34 52  ~2.87 +0.262 -0.294 296 20 ~-2 00 3.~  49Del Cap
8417 22 00 53.7 +64 08 26  ~4.29 +0.208 +0.089 358 30 +65 30 5.~  17Xi Cep
8499 22 11 33.4 -08 16 53  ~4.16 +0.117 -0.019 306 10 ~+3 00 4.~  43The Aqr
8518 22 16 29.5 -01 53 29  ~3.84 +0.129 +0.012 309 30 ~+8 45 3.~  48Gam Aqr
8684 22 45 10.5 +24 04 25  ~3.48 +0.148 -0.036 327 00 +29 30 4.~  48Mu Peg
8775 22 58 55.5 +27 32 25  ~2.42 +0.188 +0.142 332 10 +31 00 2.3  53Bet Peg
8974 23 35 14.3 +77 04 27  ~3.21 -0.065 +0.156 ~33 00 +64 15 4.~  35Gam Cep
}
```

ANNEX 3

The description of the Horos program as used for the purposes of dating the Egyptian zodiacs

We have written the astronomical program entitled "Horos" for the estimation of the dates ciphered in Egyptian zodiacs; it is available freely online at http://chronologia.polisma.net and chronologia.org (also see the URLs provided in the bibliography).

The Horos program was written in Fortran. Its objective is the astronomical dating of the ancient zodiacs. It calculates all possible datings using the information on the distribution of planets across the zodiacal constellations, specified roughly. If the source indicates a certain order of planets on the ecliptic, the program marks all the dates that correspond to this planetary order.

The set of planets doesn't need to be complete. The disposition of certain planets can be random in relation to each other, and fixed for the other planets; such situations are accounted for in the Horos software.

Horos is based on the PLANETAP program written in Fortran ([1064:0]) that calculates the ecliptic longitudes of Saturn, Jupiter, Mercury, Mars and Venus as seen from the Earth. The positions of the Moon on the celestial sphere were calculated with the aid of another program entitled ELP2000-85 (version 1.0), also written in Fortran ([1405:1]). Both programs were written by the specialists from the Parisian Longitude Bureau ("*Bureau des Longitudes*").

In order to use the Horos software, one has to copy the following files into a separate directory:

HOROS.EXE – the executable binary of the program.

SERIES85 – auxiliary file containing parameters for astronomical calculations. This file cannot be edited (unless the reader is a professional astronomer). In order to make sure that the file wasn't changed by mistake, one has to verify it. The file should have the size of 68.580 kilobytes, and the date of its creation should read as 3-07-88.

INPUT.TXT is the input data file where one has to specify the data concerning the horoscope to be dated. The program shall read the data from the file and find all the dates that correspond to the specifications on the interval between 500 B.C. and 2000 A.D. The program shall then generate a file named OTVET.TXT in the same directory upon completion of calculations.

The file INPUT.TXT specifies positions in zodiacal constellations (not to be confused with the zodiacal signs as used in astrology) of all or some of the planets from the following list:

The Sun, the Moon, Mercury, Venus, Mars, Saturn and Jupiter.

All of the abovementioned celestial bodies were known as planets in ancient astronomy, which is the term we shall be using herein for the sake of brevity.

The positions of planets in INPUT.TXT are specified according to the cyclic "constellation scale", whose detailed description can be found in CHRON3, Chapter 16:10. It was designed for making it feasible to introduce the zodiacal data into the input file directly, just as they are read from the ancient zodiac, so as to eschew consultation with astronomical reference books.

The position of every planet is specified as an interval (from/to), as given between two points of the ecliptic. Moreover, each planet can get a "best point" ascribed to it, or the point of the planet's approximate location on the ecliptic according to the indications of the ancient zodiac. The primary end served by the "best points" is the definition of planetary order on the ecliptic. The Horos program defines the order of planets as the order of their "best points". If several planets from an ancient zodiac are drawn in such a manner that estimating their respective order with certainty is a non-option, they should all be ascribed the same best point, in which case the program shall consider any mutual disposition of these planets correct; however, their position in relation to other planets with different best points shall still be subject to verification.

If a planetary position is given as "0 to 12", the implication is that the planet's place on the ecliptic isn't limited in any way at all.

If a best point of a planet (or several planets) has a value greater than 100, it is presumed to be undefined for the planet in question. In this case, any position the planet occupies in relation to other planets on the ecliptic is considered correct.

If the calculated planetary order for the given date differs from the one specified in the file INPUT.TXT, we see a corresponding message in the output file (OTVET.TXT), accompanied by the symbol "++++++".

Apart from that, the Horos program calculates the average deviation of calculated planetary positions from the "best points" specified for said planets. We are concerned with the longitudinal deviation – across the ecliptic, that is. Average deviation rates are included in the OTVET.TXT file. They can be useful for the approximated comparison of solutions and the degree of correspondence between the calculated planetary positions and the specifications of the zodiac.

The input files for the finite decipherments of the primary horoscopes from the Egyptian zodiacs as mentioned in our book can be seen in Annex 4.

The INPUT.TXT file can contain comments – however, the lines that contain actual code and begin with the hash symbol ("#") cannot be altered. These lines must begin with the hash symbol; they cannot be preceded by any spaces or tabulation.

Lines with code are followed by the respective data lines, which is where one has to enter the data concerning the horoscope under study.

Let us cite an example of an INPUT.TXT file with comments and explanations. Bear in mind that the software will interpret any lines that don't contain the hash symbol as comments.

A SPECIMEN INPUT.TXT FILE

INPUT DATA FOR **HOROS**, THE HOROSCOPE DATA CALCULATION SOFTWARE

```
@                         DATA
@                       MY ZODIAC
@ SUN MOON SATURN JUPITER MARS VENUS MERCURY
# FROM: ------------------------------------------- #
  11.0   1.0    9.0     11.0   10.0    .0      .0
# TO: --------------------------------------------- #
   1.0  12.0   11.0      1.0   12.0   2.0     2.0
# BEST POINTS: ------------------------------------ #
  11.5   200    9.5     12.0   11.0    .5     1.0
@                      END OF DATA
```

The "constellation scale" used for introducing data into the file:

<0> Aries <1> Taur <2> Gemini <3> Cancer <4> Leo <5> Virgo <6> Lib <7> Scorp <8> Sagittarius <9> Capricorn <10> Aquarius <11> Pisces <12=0>

NOTES.

This file can be altered arbitrarily; however, the lines with hash signs that precede data lines need to remain intact and unaltered. The order of data lines also needs to be maintained immutable.

Data lines are located at the beginning of the file.

Boundaries of constellations in the ecliptic of 2000 (J2000) in degrees:

<26deg> Aries <51deg> Taurus <89deg> Gemini <117deg>
<118deg> Cancer <143deg> Leo <174deg> Virgo <215deg>
<215deg> Libra <236deg> Scorpio <266deg>
<266deg> Sagittarius <301deg> Capricorn <329deg>
<329deg> Aquarius <346deg> Pisces <26deg>

We are using an arbitrary integer scale (mod 12) of constellations, specifying the planetary positions in a horoscope thereupon. Each constellation corresponds to an interval whose value equals one. The lengths of these arbitrary units vary; they correspond to the lengths of the zodiacal constellations on the ecliptic. For example, a value of 3.5 corresponds to the middle of the Cancer constellation. The upper and lower boundaries both need to be specified for each planet, as well as the approximate position of the latter. The order of points specifying approximated planetary positions has to correspond to the planetary order of the horoscope; the software verifies this order for every calculated solution.

If a planet isn't included in the horoscope, the boundary values need to be specified between 0 and 12, and the value that corresponds to the approximate location point can equal 200, for instance, or any other number above 100, which will make the program consider it unspecified. In this case it is estimated from the calculated position of this planet in relation to others in every computation. The program goes over all the planets, and every unidentified planet is placed right in between its calculated neighbours, whose approximate disposition points are already known.

The software shall report all unspecified approximate disposition points.

If several planets in a horoscope occupy the same place, and the planetary order in the group isn't unambiguous, these planets all need to be ascribed the same approximate disposition point. In this case the program shall go through all combinations of planets within the group, choosing the one that it estimates the closest to the calculated combination.

Apart from that, the program calculates the average deviations of planetary positions from the approximate disposition points.

Approximate disposition points don't affect the choice of solutions that one finds in the OTVET.TXT file – extraneous solutions bound for rejection are defined by planetary disposition boundaries exclusively. The program allows for deviations of *** degrees maximum (the *** value is chosen by the software).

The output data file is called OTVET.TXT.

Input data for the Horos program that yielded finite interpretation options

In the present annex we give the listings of input data files as used by the Horos software. Due to lack of space, we cannot cite all the input data files for all possible decipherment options of Egyptian zodiacs. The only files we cite correspond to the versions that turned out to be finite, or yielded complete solutions.

The readers can compile data files with their own interpretation versions of Egyptian zodiacs, and use the Horos software in order to get an astronomical solution of the zodiac and restore the date transcribed therein. The program in question is available online as freeware.

One must bear in mind that everything except for the command lines that begin with hash signs (#) and the data lines that follow them is just commentary, which can be altered freely, the only limitation being that the hash sign cannot be used in comments.

The hash symbol (#) must be the first symbol of a command line, and its place must be immutable.

Data lines must be altered for the compilation of a new data file. Planetary locations in zodiacal constellations must be given in accordance with the "constellation scale", qv in Chron3, Chapter 16:10.

<0> Aries <1> Taur <2> Gemini <3> Cancer <4> Leo <5> Virgo <6> Lib <7> Scorp <8> Sagittarius <9> Capricorn <10> Aquarius <11> Pisces <12=0>

DATA FOR THE HOROS PROGRAM

Zodiac: The Long Zodiac of Dendera (DL).
Interpretation version: The Sun is a circle in Taurus, Moon in Pisces.
Interpretation version code: DL2.
Planetary positions in the primary horoscope:
The Sun is the circle on the back of Taurus. Allowable position range: from the middle of Aries to the middle of Gemini, the best point is in the middle of Taurus.
The Moon is the circle in Libra, or the circle between Libra and Scorpio. Allowable positions: Libra or Scorpio; best point – middle of Libra.
Saturn in Aquarius or Capricorn. Allowable positions: Aquarius or Capricorn; best point falls on the cusp between the two.
Jupiter in Pisces or Aries. Allowable positions: Pisces or Aries; best point – cusp of Pisces and Aries.
Mars in Pisces or Aquarius. Allowable positions: Pisces or Aquarius, best point – middle of Aquarius.
Venus in Aries or Taurus. Allowable positions: Aries or Taurus, the best point shall mark the third of Aries (very near to the constellation's middle).
Mercury in Aries, Taurus or Gemini. Allowable positions: Aries, Taurus or Gemini. Best point – middle of Taurus (approximated from two versions).

All the allowable position boundaries may be trespassed by a value of up to five arc degrees.
Planetary order on the ecliptic as counted from the autumn equinox point (the procession's head on the zodiac), arranged by growing latitudinal values:
Moon Saturn Mars Jupiter Venus Mercury <–> Sun.
Mercury can swap positions with the Sun, since it is drawn on both sides of the latter.

DATA

	Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
# FROM:	0.5	6.0	9.0	11.0	10.0	.0	.0
# TO:	2.5	8.0	11.0	1.0	12.0	2.0	3.0
# BEST POINTS:	1.5	6.5	10.0	12.0	10.5	.3	1.5

END OF DATA

DATA FOR THE HOROS PROGRAM

Zodiac: The Round Zodiac of Dendera (DR).
Interpretation version: Moon in Libra.
Interpretation version code: DR9.
Planetary positions in the primary horoscope:
Sun in Pisces.
Mercury in Aquarius or in Pisces.
Saturn in Virgo or in Libra.
Moon in Libra.
Mars in Capricorn.
Venus in Aries or in Pisces.
Jupiter in Cancer or in Gemini.
All the allowable position boundaries may be trespassed by a value of up to five arc degrees.
Planetary order on the ecliptic as counted from the autumn equinox point arranged by growing latitudinal values:
Venus Jupiter Saturn Moon Mars Mercury Sun.

DATA

	Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
# FROM:	10.5	5.5	5.0	2.0	9.0	11.0	10.0
# TO:	0.5	7.5	7.0	4.0	10.0	1.0	12.0
# BEST POINTS:	11.5	6.5	5.5	3.5	9.5	.5	11.0

END OF DATA

DATA FOR THE HOROS PROGRAM

Zodiac: The Greater Zodiac of Esna (EB).
Interpretation version: all possibilities included.
Interpretation version code: EB1.
Planetary positions in the primary horoscope:
Sun and Moon in Pisces, Taurus or Aries (a test for exact correspondence to the zodiac is required).
Saturn in Libra or in Virgo.
Mercury, Mars, Venus and Jupiter in Pisces or in Aquarius.
All the allowable position boundaries may be trespassed by a value of up to five arc degrees.
Planetary order must be verified additionally.
Possible planetary order options (from Aquarius to Pisces)*:*
Mercury Mars Venus Jupiter
or Mercury Jupiter Venus Mars.

DATA

	Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
# FROM:	11.0	11.0	5.0	10.0	10.0	10.0	10.0
# TO:	2.0	2.0	7.0	12.0	12.0	12.0	12.0
# BEST POINTS:	1.0	1.0	5.5	11.5	11.5	11.5	11.5

END OF DATA

DATA FOR THE HOROS PROGRAM

Zodiac: The Lesser Zodiac of Esna (EM).
Interpretation version: lower row horoscope with both planetary parentheses accounted for.
Interpretation version code: EMS.
Planetary positions in the primary horoscope:
Sun in Taurus.

Moon in Aries.
Saturn in Aquarius.
Mercury in Taurus or in the middle of Taurus; can swap places with the Sun.
Mars in Gemini.
Venus in Taurus, closer to Gemini.
Jupiter in Capricorn or in Sagittarius.

DATA

	Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
# FROM:	1.0	0.0	10.0	8.0	2.0	1.0	0.5
# TO:	2.0	1.0	11.0	10.0	3.0	2.0	2.0
# BEST POINTS:	1.5	0.5	10.5	9.0	2.5	1.9	1.5

END OF DATA

DATA FOR THE HOROS PROGRAM (THE UPPER ZODIAC OF ATHRIBIS)

Interpretation version: A1.
Planetary positions are in rigid correspondence with the zodiac.
Data code: AV1.
Sun in Taurus, interchangeable with bird 4.
Moon in Gemini (+/– half of constellation – approximation made due to the effects of lunar speed)
Saturn in Aquarius/Capricorn (bird 3).
Mercury in Taurus or the middle of Gemini (man with a rod).
Mars in Taurus or the middle of Aries (bird 4).
Venus in Gemini or Cancer (bird 2 in each case).
Jupiter in Pisces or the middle of Aquarius (bird 1)

DATA

	Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
# FROM:	1.0	1.5	9.0	10.5	0.5	2.0	1.0
# TO:	2.0	3.5	11.0	0.0	2.0	4.0	2.5
# BEST POINTS:	1.5	2.5	9.5	11.5	1.5	3.0	1.8

END OF DATA

DATA FOR THE HOROS PROGRAM (THE LOWER ZODIAC OF ATHRIBIS)

Interpretation version: A1.
Planetary positions are in rigid correspondence with the zodiac
Data code: AN1.
Sun in Aquarius/Capricorn.
Moon in Sagittarius (+/– half of constellation – approximation made due to the effects of lunar speed).
Saturn in Capricorn or the middle of Sagittarius (bird 3).
Mercury in Pisces (the man with the rod).
Mars in Leo (bird 2).
Venus in Aquarius or the middle of Pisces (bird 2 in each case).
Jupiter in Gemini (bird 1).

DATA

	Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
# FROM:	9.0	7.5	8.5	2.0	4.0	10.0	11.0
# TO:	11.0	9.5	10.0	3.0	5.0	11.5	12.0
# BEST POINTS:	10.0	8.5	9.5	2.5	4.5	10.2	11.5

END OF DATA

DATA FOR THE HOROS PROGRAM (THE UPPER ZODIAC OF ATHRIBIS)

Interpretation version: A2.
Planetary positions are in rigid correspondence with the zodiac
Data code: AV2.
Sun in Taurus, interchangeable with bird 4.
Moon in Gemini (+/– half of constellation – approximation made due to the effects of lunar speed)
Saturn in Taurus or the middle of Aries (bird 4).
Mercury in Taurus or the middle of Gemini (man with a rod).

Mars in Aquarius/Capricorn (bird 3).
Venus in Gemini or Cancer (bird 2 in each case).
Jupiter in Pisces or the middle of Aquarius (bird 1)

DATA

	Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
# FROM:	1.0	1.5	0.5	10.5	9.0	2.0	1.0
# TO:	2.0	3.5	2.0	0.0	11.0	4.0	2.5
# BEST POINTS:	1.5	2.5	1.5	11.5	9.5	3.0	1.8

END OF DATA

DATA FOR THE HOROS PROGRAM
(THE LOWER ZODIAC OF ATHRIBIS)

Interpretation version: A2.
Planetary positions are in rigid correspondence with the zodiac
Data code: AN2.
Sun in Aquarius/Capricorn.
Moon in Sagittarius (+/– half of constellation – approximation made due to the effects of lunar speed).
Saturn in Leo (bird 4).
Mercury in Pisces (the man with the rod).
Mars in Capricorn or the middle of Sagittarius (bird 3).
Venus in Aquarius or the middle of Pisces (bird 2 in each case).
Jupiter in Gemini (bird 1).

DATA

	Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
# FROM:	9.0	7.5	4.0	2.0	8.5	10.0	11.0
# TO:	11.0	9.5	5.0	3.0	10.0	11.5	12.0
# BEST POINTS:	10.0	8.5	4.5	2.5	9.5	10.5	11.5

END OF DATA

DATA FOR THE HOROS PROGRAM
(THE UPPER ZODIAC OF ATHRIBIS)

Interpretation version: A3.
Planetary positions are in rigid correspondence with the zodiac
Data code: AV3.
Sun in Taurus, interchangeable with bird 4.
Moon in Gemini (+/– half of constellation – approximation made due to the effects of lunar speed)
Saturn in Pisces or the middle of Aquarius (bird 1).
Mercury in Taurus or the middle of Gemini (man with a rod).
Mars in Taurus or the middle of Aries (bird 4).
Venus in Gemini or Cancer (bird 2 in each case).
Jupiter in Aquarius/Capricorn (bird 3).

DATA

	Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
# FROM:	1.0	1.5	10.5	9.0	0.5	2.0	1.0
# TO:	2.0	3.5	0.0	11.0	2.0	4.0	2.5
# BEST POINTS:	1.5	2.5	11.5	9.5	1.5	3.0	1.8

END OF DATA

DATA FOR THE HOROS PROGRAM
(THE LOWER ZODIAC OF ATHRIBIS)

Interpretation version: A3.
Planetary positions are in rigid correspondence with the zodiac
Data code: AN3.
Sun in Aquarius/Capricorn.
Moon in Sagittarius (+/– half of constellation – approximation made due to the effects of lunar speed).
Saturn in Gemini (bird 1).
Mercury in Pisces (the man with the rod).
Mars in Leo (bird 4).
Venus in Aquarius or the middle of Pisces (bird 2 in each case).
Jupiter in Capricorn or the middle or Sagittarius (bird 3).

DATA

	Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
# FROM:	9.0	7.5	2.0	8.5	4.0	10.0	11.0
# TO:	11.0	9.5	3.0	10.0	5.0	11.5	12.0
# BEST POINTS:	10.0	8.5	2.5	9.5	4.5	10.2	11.5

END OF DATA

DATA FOR THE HOROS PROGRAM (THE UPPER ZODIAC OF ATHRIBIS)

Interpretation version: A4.
Planetary positions are in rigid correspondence with the zodiac.
Data code: AV4.
Sun in Taurus, interchangeable with bird 4.
Moon in Gemini (+/– half of constellation – approximation made due to the effects of lunar speed)
Saturn in Taurus or the middle of Aries (bird 4).
Mercury in Taurus or the middle of Gemini (man with a rod).
Mars in Pisces or the middle of Aquarius (bird 1).
Venus in Gemini or Cancer (bird 2 in each case).
Jupiter in Aquarius/Capricorn (bird 3)

DATA

	Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
# FROM:	1.0	1.5	0.5	9.0	10.5	2.0	1.0
# TO:	2.0	3.5	2.0	11.0	0.0	4.0	2.5
# BEST POINTS:	1.5	2.5	1.5	9.5	11.5	3.0	1.8

END OF DATA

DATA FOR THE HOROS PROGRAM (THE LOWER ZODIAC OF ATHRIBIS)

Interpretation version: A4.
Planetary positions are in rigid correspondence with the zodiac
Data code: AN4.
Sun in Aquarius/Capricorn.
Moon in Sagittarius (+/– half of constellation – approximation made due to the effects of lunar speed).
Saturn in Leo (bird 4).
Mercury in Pisces (man with the rod).
Mars in Gemini (bird 1). *Venus* in Aquarius or the middle of Pisces (bird 2 in each case).
Jupiter in Capricorn or the middle or Sagitt. (bird 3).

DATA

	Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
# FROM:	9.0	7.5	4.0	8.5	2.0	10.0	11.0
# TO:	11.0	9.5	5.0	10.0	3.0	11.5	12.0
# BEST POINTS:	10.0	8.5	4.5	9.5	2.5	10.2	11.5

END OF DATA

DATA FOR THE HOROS PROGRAM (THE UPPER ZODIAC OF ATHRIBIS)

Interpretation version: A5.
Planetary positions are in rigid correspondence with the zodiac
Data code: AV5.
Sun in Taurus, interchangeable with bird 4.
Moon in Gemini (+/– half of constellation – approximation made due to the effects of lunar speed)
Saturn in Pisces or the middle of Aquarius (bird 1).
Mercury in Taurus or the middle of Gemini (man with a rod).
Mars in Aquarius/Capricorn (bird 3).
Venus in Gemini or Cancer (bird 2 in each case).
Jupiter in Taurus or the middle of Aries (bird 4).

DATA

	Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
# FROM:	1.0	1.5	10.5	0.5	9.0	2.0	1.0

# TO:	2.0	3.5	0.0	2.0	11.0	4.0	2.5
# BEST POINTS:	1.5	2.5	11.5	1.5	9.5	3.0	1.8

END OF DATA

DATA FOR THE HOROS PROGRAM (THE LOWER ZODIAC OF ATHRIBIS)

Interpretation version: A5.
Planetary positions are in rigid correspondence with the zodiac
Data code: AN5.
Sun in Aquarius/Capricorn.
Moon in Sagittarius (+/– half of constellation – approximation made due to the effects of lunar speed).
Saturn in Gemini (bird 1).
Mercury in Pisces (man with the rod).
Mars in Capricorn or the middle or Sagittarius (bird 3).
Venus in Aquarius or the middle of Pisces (bird 2 in each case).
Jupiter in Leo (bird 4).

DATA

	Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
# FROM:	9.0	7.5	2.0	4.0	8.5	10.0	11.0
# TO:	11.0	9.5	3.0	5.0	10.0	11.5	12.0
# BEST POINTS:	10.0	8.5	2.5	4.5	9.5	10.2	11.5

END OF DATA

DATA FOR THE HOROS PROGRAM (THE UPPER ZODIAC OF ATHRIBIS)

Interpretation version: A6.
Planetary positions are in rigid correspondence with the zodiac
Data code: AV6.
Sun in Taurus, interchangeable with bird 4.
Moon in Gemini (+/– half of constellation – approximation made due to the effects of lunar speed)
Saturn in Aquarius/Capricorn (bird 3).
Mercury in Taurus or the middle of Gemini (man with a rod).
Mars in Pisces or the middle of Aquarius (bird 1).
Venus in Gemini or Cancer (bird 2 in each case).
Jupiter in Taurus or the middle of Aries (bird 4)

DATA

	Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
# FROM:	1.0	1.5	9.0	0.5	10.5	2.0	1.0
# TO:	2.0	3.5	11.0	2.0	0.0	4.0	2.5
# BEST POINTS:	1.5	2.5	9.5	1.5	11.5	3.0	1.8

END OF DATA

DATA FOR THE HOROS PROGRAM (THE LOWER ZODIAC OF ATHRIBIS)

Interpretation version: A6.
Planetary positions are in rigid correspondence with the zodiac
Data code: AN6.
Sun in Aquarius/Capricorn.
Moon in Sagittarius (+/– half of constellation – approximation made due to the effects of lunar speed).
Saturn in Capricorn or the middle or Sagittarius (bird 3).
Mercury in Pisces (man with the rod).
Mars in Gemini (bird 1).
Venus in Aquarius or the middle of Pisces (bird 2 in each case).
Jupiter in Leo (bird 4).

DATA

	Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
# FROM:	9.0	7.5	8.5	4.0	2.0	10.0	11.0
# TO:	11.0	9.5	10.0	5.0	3.0	11.5	12.0

# BEST POINTS:	10.0	8.5	9.5	4.5	2.5	10.2	11.5

END OF DATA

DATA FOR THE HOROS PROGRAM (THE UPPER ZODIAC OF ATHRIBIS)

Interpretation version: A1.
Planetary order for the group: (Sun) – (planet 4) – (Mercury) is *random*.
Data code: AVA.
Sun in Taurus, interchangeable with bird 4.
Moon in Gemini (+/– half of constellation – approximation made due to the effects of lunar speed)
Saturn in Aquarius/Capricorn (bird 3).
Mercury in Taurus or the middle of Gemini (man with a rod).
Mars in Taurus or the middle of Aries (bird 4)
Venus in Gemini or Cancer (bird 2 in each case).
Jupiter in Pisces or the middle of Aquarius (bird 1).

DATA

	Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
# FROM:	1.0	1.5	9.0	10.5	0.5	2.0	1.0
# TO:	2.0	3.5	11.0	0.0	2.0	4.0	2.5
# BEST POINTS:	1.5	2.5	9.5	11.5	1.5	3.0	1.5

END OF DATA

DATA FOR THE HOROS PROGRAM (THE LOWER ZODIAC OF ATHRIBIS)

Interpretation version: A1.
Planetary order for the group: (Sun) – (Venus) – (Mercury) is *random*.
Data code: ANA.
Sun in Aquarius/Capricorn.
Moon in Sagittarius (+/– half of constellation – approximation made due to the effects of lunar speed).
Mercury in Aquarius or in Pisces man with the rod).
Venus in Capricorn, Aquarius or the middle of Pisces (bird 2 in each case).
The Sun, Mercury and Venus are all interchangeable.
Saturn in Capricorn or the middle of Sagittarius (bird 3).
Jupiter in Gemini (bird 1).
Mars in Leo (bird 4).

DATA

	Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
# FROM:	9.0	7.5	8.5	2.0	4.0	9.0	10.0
# TO:	11.0	9.5	10.0	3.0	5.0	11.5	12.0
# BEST POINTS:	10.5	8.5	9.5	2.5	4.5	10.5	10.5

END OF DATA

DATA FOR THE HOROS PROGRAM (THE UPPER ZODIAC OF ATHRIBIS)

Interpretation version: A2.
Planetary order for the group: (Sun) – (planet 4) – (Mercury) is *random*.
Data code: AVB.
Sun in Taurus, interchangeable with bird 4.
Moon in Gemini (+/– half of constellation – approximation made due to the effects of lunar speed)
Saturn in Taurus or the middle of Aries (bird 4).
Mercury in Taurus or the middle of Gemini (man with a rod).
Mars in Aquarius/Capricorn (bird 3).
Venus in Gemini or Cancer (bird 2 in each case).
Jupiter in Pisces or the middle of Aquarius (bird 1).

DATA

	Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
# FROM:	1.0	0.0	0.5	10.5	9.0	2.0	1.0
# TO:	2.0	3.5	2.0	0.0	11.0	4.0	2.5
# BEST POINTS:	1.5	2.5	1.5	11.5	9.5	3.0	1.5

END OF DATA

DATA FOR THE HOROS PROGRAM (THE LOWER ZODIAC OF ATHRIBIS)

Interpretation version: A2.
Planetary order for the group: (Sun) – (Venus) – (Mercury) is *random*.
Data code: ANB.
The Sun in Aquarius/Capricorn is interchangeable with Venus (bird 2).
Moon in Sagittarius (+/– half of constellation – approximation made due to the effects of lunar speed).
Mercury in Aquarius or Pisces (man with the rod).
Venus in Capricorn, Aquarius or the middle of Pisces (bird 2 in each case).
The Sun, Mercury and Venus are all interchangeable.
Saturn in Leo (bird 4).
Mars is in Capricorn or the middle of Sagittarius (bird 3).
Jupiter in Gemini (bird 1).

DATA

	Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
# FROM: #	9.0	7.5	4.0	2.0	8.5	9.0	10.0
# TO: #	11.0	9.5	5.0	3.0	10.0	11.5	12.0
# BEST POINTS: #	10.0	8.5	4.5	2.5	9.5	10.5	10.5

END OF DATA

DATA FOR THE HOROS PROGRAM (THE UPPER ZODIAC OF ATHRIBIS)

Interpretation version: A3.
Planetary order for the group: (Sun) – (planet 4) – (Mercury) is *random*.
Data code: AVC.
Sun in Taurus, interchangeable with bird 4.
Moon in Gemini (+/– half of constellation – approximation made due to the effects of lunar speed).
Saturn in Pisces or the middle of Aquarius (bird 1).
Mercury in Taurus or the middle of Gemini (man with a rod).
Mars in Taurus or the middle of Aries (bird 4).
Venus in Gemini or Cancer (bird 2 in each case).
Jupiter in Aquarius/Capricorn (bird 3).

DATA

	Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
# FROM: #	1.0	0.0	10.5	9.0	0.5	2.0	1.0
# TO: #	2.0	3.5	0.0	11.0	2.0	4.0	2.5
# BEST POINTS: #	1.5	2.5	11.5	9.5	1.5	3.0	1.5

END OF DATA

DATA FOR THE HOROS PROGRAM (THE LOWER ZODIAC OF ATHRIBIS)

Interpretation version: A3.
Planetary order for the group: (Sun) – (Venus) – (Mercury) is *random*.
Data code: ANC.
The Sun in Aquarius/Capricorn is interchangeable with Venus (bird 2).
Moon in Sagittarius (+/– half of constellation – approximation made due to the effects of lunar speed).
Mercury in Aquarius or in Pisces (the man with the rod).
Venus in Capricorn, Aquarius or the middle of Pisces (bird 2 in each case).
The Sun, Mercury and Venus are all interchangeable.
Saturn in Gemini (bird 1).
Mars in Leo (bird 4).
Jupiter in Capricorn or the middle or Sagittarius (bird 3).

DATA

	Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
# FROM: #	9.0	7.5	2.0	8.5	4.0	9.0	10.0
# TO: #	11.0	9.5	3.0	10.0	5.0	11.5	12.0

# best points:	10.0	8.5	2.5	9.5	4.5	10.2	10.5

END OF DATA

DATA FOR THE HOROS PROGRAM (THE UPPER ZODIAC OF ATHRIBIS)

Interpretation version: A4.
Planetary order for the group: (Sun) – (planet 4) – (Mercury) is *random*.
Data code: AVD.
Sun in Taurus, interchangeable with bird 4.
Moon in Gemini (+/– half of constellation – approximation made due to the effects of lunar speed)
Saturn in Taurus or the middle of Aries (bird 4).
Mercury in Taurus or the middle of Gemini (man with a rod).
Mars in Pisces or the middle of Aquarius (bird 1).
Venus in Gemini or Cancer (bird 2 in each case).
Jupiter in Aquarius/Capricorn (bird 3).

DATA

	Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
# from:	1.0	0.0	0.5	9.0	10.5	2.0	1.0
# to:	2.0	3.5	2.0	11.0	0.0	4.0	2.5
# best points:	1.5	2.5	1.5	9.5	11.5	3.0	1.5

END OF DATA

DATA FOR THE HOROS PROGRAM (THE LOWER ZODIAC OF ATHRIBIS)

Interpretation version: A4.
Planetary order for the group: (Sun) – (Venus) – (Mercury) is *random*.
Data code: AND.
The Sun in Aquarius/Capricorn is interchangeable with Venus (bird 2).
Moon in Sagittarius (+/– half of constellation – approximation made due to the effects of lunar speed).
Mercury in Aquarius or in Pisces (man with the rod).
Venus in Capricorn, Aquarius or the middle of Pisces (bird 2 in each case).
The Sun, Mercury and Venus are all interchangeable.
Saturn in Leo (bird 4).
Mars in Gemini (bird 1).
Jupiter in Capricorn or the middle or Sagitt. (bird 3).

DATA

	Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
# from:	9.0	7.5	4.0	8.5	2.0	9.0	10.0
# to:	11.0	9.5	5.0	10.0	3.0	11.5	12.0
# best points:	10.5	8.5	4.5	9.5	2.5	10.5	10.5

END OF DATA

DATA FOR THE HOROS PROGRAM (THE UPPER ZODIAC OF ATHRIBIS)

Interpretation version: A5.
Planetary order for the group: (Sun) – (planet 4) – (Mercury) is *random*.
Data code: AVE.
Sun in Taurus, interchangeable with bird 4.
Moon in Gemini (+/– half of constellation – approximation made due to the effects of lunar speed).
Saturn in Pisces or the middle of Aquarius (bird 1).
Mercury in Taurus or the middle of Gemini (man with a rod).
Mars in Aquarius/Capricorn (bird 3).
Venus in Gemini or Cancer (bird 2 in each case).
Jupiter in Taurus or the middle of Aries (bird 4).

DATA

	Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
# from:	1.0	0.0	10.5	0.5	9.0	2.0	1.0
# to:	2.0	3.5	0.0	2.0	11.0	4.0	2.5
# best points:	1.5	2.5	11.5	1.5	9.5	3.0	1.5

END OF DATA

DATA FOR THE HOROS PROGRAM
(THE LOWER ZODIAC OF ATHRIBIS)

Interpretation version: A5.
Planetary order for the group: (Sun) – (Venus) – (Mercury) is *random*.
Data code: ANE.
The Sun in Aquarius/Capricorn is interchangeable with Venus (bird 2).
Moon in Sagittarius (+/– half of constellation – approximation made due to the effects of lunar speed).
Mercury in Aquarius or in Pisces (man with the rod).
Venus in Capricorn, Aquarius or the middle of Pisces (bird 2 in each case).
The Sun, Mercury and Venus are all interchangeable.
Saturn in Gemini (bird 1).
Mars in Capricorn or the middle or Sagittarius (bird 3).
Jupiter in Leo (bird 4).

DATA

	Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
# FROM:	9.0	7.5	2.0	4.0	8.5	9.0	10.0
# TO:	11.0	9.5	3.0	5.0	10.0	11.5	12.0
# BEST POINTS:	10.5	8.5	2.5	4.5	9.5	10.5	10.5

END OF DATA

DATA FOR THE HOROS PROGRAM
(THE UPPER ZODIAC OF ATHRIBIS)

Interpretation version: A6.
Planetary order for the group: (Sun) – (planet 4) – (Mercury) is *random*.
Data code: AVF.
Sun in Taurus, interchangeable with bird 4.
Moon in Gemini (+/– half of constellation – approximation made due to the effects of lunar speed).
Saturn in Aquarius/Capricorn (bird 3).
Mercury in Taurus or the middle of Gemini (man with a rod).
Mars in Pisces or the middle of Aquarius (bird 1).
Venus in Gemini or Cancer (bird 2 in each case).
Jupiter in Taurus or the middle of Aries (bird 4).

DATA

	Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
# FROM:	1.0	0.0	9.0	0.5	10.5	2.0	1.0
# TO:	2.0	3.5	11.0	2.0	0.0	4.0	2.5
# BEST POINTS:	1.5	2.5	9.5	1.5	11.5	3.0	1.5

END OF DATA

DATA FOR THE HOROS PROGRAM
(THE LOWER ZODIAC OF ATHRIBIS)

Interpretation version: A6.
Planetary order for the group: (Sun) – (Venus) – (Mercury) is *random*.
Data code: ANF.
The Sun in Aquarius/Capricorn is interchangeable with Venus (bird 2).
Moon in Sagittarius (+/– half of constellation – approximation made due to the effects of lunar speed).
Mercury in Aquarius or in Pisces (man with the rod).
Venus in Capricorn, Aquarius or the middle of Pisces (bird 2 in each case).
The Sun, Mercury and Venus are all interchangeable.
Saturn in Capricorn or the middle or Sagitt. (bird 3).
Mars in Gemini (bird 1).
Jupiter in Leo (bird 4).

DATA

	Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
# FROM:	9.0	7.5	8.5	4.0	2.0	9.0	10.0
# TO:	11.0	9.5	10.0	5.0	3.0	11.5	12.0
# BEST POINTS:	10.5	8.5	9.5	4.5	2.5	10.5	10.5

END OF DATA

DATA FOR THE HOROS PROGRAM (THE LOWER ZODIAC OF ATHRIBIS)

Interpretation version: A1. The group of (planet 3) – (Sun) – (Venus) – (Mercury) is only tied to the ecliptic by the Sun, which is in Scorpio/Capricorn. *The planetary order inside the group is random.*
Data code: ANO.
Sun in Aquarius/Capricorn.
Moon in Sagittarius (+/– half of constellation – approximation made due to the effects of lunar speed).
Mercury in Capricorn, Aquarius or in Pisces (the man with the rod). *Venus* in Capricorn, Aquarius or the middle of Pisces (bird 2 in each case).
The Sun, Mercury and Venus are all interchangeable.
Saturn in Capricorn or the middle of Sagitt.(bird 3).
Jupiter in Gemini (bird 1). *Mars* in Leo (bird 4).

DATA

	Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
# FROM: #	9.0	7.5	8.5	2.0	4.0	9.0	9.0
# TO: #	11.0	9.5	11.0	3.0	5.0	12.0	12.0
# BEST POINTS: #	10.0	8.5	10.0	2.5	4.5	10.0	10.0

END OF DATA

DATA FOR THE HOROS PROGRAM (THE LOWER ZODIAC OF ATHRIBIS)

Interpretation version: A2. The group of (planet 3) – (Sun) – (Venus) – (Mercury) is only tied to the ecliptic by the Sun, which is in Scorpio/Capricorn.
The planetary order inside the group is random.
Data code: ANP.
The Sun is in Aquarius/Capricorn.
Moon in Sagittarius (+/– half of constellation – approximation made due to the effects of lunar speed).
Mercury in Capricorn, Aquarius or Pisces (the man with the rod).
Venus in Capricorn, Aquarius or Pisces (bird 2 in each case).
Saturn in Leo (bird 4).
Mars is in Capricorn or the middle of Sagittarius (bird 3).
Jupiter in Gemini (bird 1).

DATA

	Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
# FROM: #	9.0	7.5	4.0	2.0	8.5	9.0	9.0
# TO: #	11.0	9.5	5.0	3.0	11.0	12.0	12.0
# BEST POINTS: #	10.0	8.5	4.5	2.5	10.0	10.0	10.0

END OF DATA

DATA FOR THE HOROS PROGRAM (THE LOWER ZODIAC OF ATHRIBIS)

Interpretation version: A3.
Planetary order for the group: (Sun) – (Venus) – (Mercury) is random. The Sun, Mercury and Venus are all interchangeable.
Data code: ANQ.
The Sun in Aquarius/Capricorn
Moon in Sagittarius (+/– half of constellation – approximation made due to the effects of lunar speed).
Mercury in Aquarius or in Pisces (the man with the rod).
Venus in Capricorn, Aquarius or the middle of Pisces (bird 2 in each case).
Saturn in Gemini (bird 1).
Mars in Leo (bird 4).
Jupiter in Capricorn or the middle or Sagittarius (bird 3).

DATA

	Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
# FROM: #	9.0	7.5	2.0	8.5	4.0	9.0	9.0
# TO: #	11.0	9.5	3.0	11.0	5.0	12.0	12.0

	Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
# BEST POINTS:	10.0	8.5	2.5	10.0	4.5	10.0	10.0

END OF DATA

DATA FOR THE HOROS PROGRAM (THE UPPER ZODIAC OF ATHRIBIS)

Interpretation version: A4.
Planetary order for the group: (planet 3) – (Sun) – (Venus) – (Mercury) is random.
Data code: ANR.
The Sun in Aquarius-Capricorn
Moon in Sagittarius (+/– half of constellation – approximation made due to the effects of lunar speed).
Mercury in Aquarius or in Pisces (the man with the rod).
Venus in Capricorn,Aquarius or the middle of Pisces (bird 2 in each case).
Mars in Gemini (bird 1).
Jupiter in Capricorn or the middle or Sagittarius (bird 3).

DATA

	Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
# FROM:	9.0	7.5	4.0	8.5	2.0	9.0	9.0
# TO:	11.0	9.5	5.0	11.0	3.0	12.0	12.0
# BEST POINTS:	10.0	8.5	4.5	9.5	2.5	10.5	11.0

END OF DATA

DATA FOR THE HOROS PROGRAM (THE LOWER ZODIAC OF ATHRIBIS)

Interpretation version: A5.
Planetary order for the group: (planet 3) – (Sun) – (Venus) – (Mercury) is random.
Data code: ANS.
The Sun in Aquarius-Capricorn
Moon in Sagittarius (+/– half of constellation – approximation made due to the effects of lunar speed).
Mercury in Aquarius or in Pisces (the man with the rod).
Venus in Capricorn, Aquarius or the middle of Pisces (bird 2 in each case).
Saturn in Gemini (bird 1).
Mars in Capricorn or the middle or Sagittarius (bird 3).
Jupiter in Leo (bird 4).

DATA

	Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
# FROM:	9.0	7.5	2.0	4.0	8.5	9.0	9.0
# TO:	11.0	9.5	3.0	5.0	11.0	12.0	12.0
# BEST POINTS:	10.0	8.5	2.5	4.5	9.5	10.5	11.0

END OF DATA

DATA FOR THE HOROS PROGRAM (THE UPPER ZODIAC OF ATHRIBIS)

Interpretation version: A6.
Data code: ANT.
The Sun in Aquarius/Capricorn
Moon in Sagittarius (+/– half of constellation – approximation made due to the effects of lunar speed).
Mercury in Capricorn , Aquarius or in Pisces (the man with the rod).
Venus in Capricorn, Aquarius or the middle of Pisces (bird 2 in each case).
Saturn in Aquarius/Capricorn or in the middle of Sagittarius (bird 3).
Mars in Gemini (bird 3).
Jupiter in Leo (bird 4).

DATA

	Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
# FROM:	9.0	7.5	8.5	4.0	2.0	9.0	9.0
# TO:	11.0	9.5	11.0	5.0	3.0	12.0	12.0
# BEST POINTS:	10.0	8.5	9.5	4.5	2.5	10.5	11.0

END OF DATA

DATA FOR THE HOROS PROGRAM
(THE ZODIAC OF BRUGSCH)

Interpretation version: BR1.
The Sun is random, verifiable in solutions.
Moon in Virgo or in Libra interchangeable with Mars.
Mercury in Scorpio or in Libra.
Venus in Scorpio or in Sagittarius.
Saturn in Leo or in beginning of Cancer.
Mars in Virgo.
Jupiter in Leo or in the beginning of Cancer interchangeable with Saturn.

DATA

	Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
# FROM:	0.0	5.0	3.7	3.7	5.0	7.0	6.0
# TO:	12.0	7.0	5.0	5.0	6.0	9.0	8.0
# BEST POINTS:	777.0	5.5	4.0	4.0	5.5	8.0	7.0

END OF DATA

DATA FOR THE HOROS PROGRAM
(THE ZODIAC OF BRUGSCH – WITHOUT RODS)

Interpretation version: BR2.
The Sun in Virgo or in Libra (bird).
Moon is random.
Mercury in Libra/Scorpio.
Venus in Leo (she-lion).
Saturn in Scorpio.
Mars in Scorpio/Sagittarius.
Jupiter in Libra/Scorpio.

DATA

	Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
# FROM:	5.0	1.0	7.0	6.0	7.0	4.0	6.0
# TO:	7.0	12.0	8.0	8.0	9.0	5.0	8.0
# BEST POINTS:	6.0	777.0	7.5	7.0	8.1	4.5	6.5

END OF DATA

DATA FOR THE HOROS PROGRAM
(THE ZODIAC OF BRUGSCH – WITHOUT RODS + MOON INFLUENCE)

Interpretation version: BR3.
The Sun in Virgo or in Libra (bird).
Moon in Leo or in Virgo.
Mercury in Libra/Scorpio.
Venus in Leo (she-lion).
Saturn in Scorpio.
Mars in Scorpio/Sagittarius.
Jupiter in Libra/Scorpio.
The order of 4 planets – Mercury, Jupiter, Saturn, Mars – is to verify manually in solutions.

DATA

	Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
# FROM:	5.0	4.0	6.0	6.0	6.0	4.0	6.0
# TO:	7.0	6.0	9.0	9.0	9.0	5.0	9.0
# BEST POINTS:	6.0	5.0	7.0	7.0	7.0	4.5	7.0

END OF DATA

DATA FOR THE HOROS PROGRAM
(THE ZODIAC OF BRUGSCH – IN BOATS)

Interpretation version: BR6.
The Sun in Aquarius/Sagittarius (bird).
Moon random.
Mercury in Pisces/Taurus interchangeable with Saturn.
Venus in Capricorn/Sagittarius.
Saturn in Scorpio.
Mars in Capricorn.
Jupiter in Capricorn/Sagittarius on Sagittarius side of Venus.

DATA

	Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
# FROM:	9.0	0.0	0.0	8.0	9.0	8.0	11.0
# TO:	11.0	12.0	1.0	10.0	10.0	10.0	2.0
# BEST POINTS:	10.0	777.0	0.5	8.5	9.5	8.9	0.5

END OF DATA

DATA FOR THE HOROS PROGRAM
(THE THEBES COLOUR ZODIAC - *OU*)

The Sun in Virgo.
Moon in Scorpio (+ one constellation – approximation made due to the effects of lunar speed).
Saturn in Leo or in Virgo bordering Leo (by the tail).
Mercury in Leo or in Virgo Leo (by the tail).
Venus in Leo.
Mars in Leo or in Virgo bordering Leo (by the tail).
Jupiter in Taurus.
Mercury, Venus, Saturn, Mars are interchangeable, but their order is not random, that is, Venus must outside of the group of Mercury, Saturn, Mars. This is to be verified manually.

DATA

	Sun	Moon	Saturn	Jupiter	Mars	Venus	Mercury
# FROM:	5.0	6.0	4.0	1.0	4.0	4.0	4.0
# TO:	6.0	9.0	5.2	2.0	5.2	5.0	5.2
# BEST POINTS:	5.5	7.5	4.5	1.5	4.5	4.5	4.5

END OF DATA

Julian day numbers and the days of solstices and equinoxes as taken for the beginnings of centuries in the past

B.C. / A.D. years. Beginnings of centuries	*The Julian day for "the 0 of January" of the first year in a century, with the years counted from midday GMT on the average (the noon of 31 December, that is); see [393], page 57*	*Spring equinox in the Julian calendar (precise); see [393], page 316. Dates in March*	*Summer equinox in the Julian calendar (approximated). Dates in June*	*Autumn equinox in the Julian calendar (approximated). Dates in September*	*Winter solstice in the Julian calendar (approximated). Dates in December*
YEARS B.C.					
501	1 538 432	26.73	26	25	25
401	1 574 957	25.93	25	24	24
301	1 611 482	25.14	24	23	23
201	1 648 007	24.35	23	22	22
101	1 684 532	23.57	23	22	22
1	1 721 057	22.78	22	21	21
YEARS A.D.					
100	1 757 582	22.00	21	20	20
200	1 794 107	21.22	20	19	19
300	1 830 632	20.43	19	18	18
400	1 867 157	19.65	19	18	18
500	1 903 682	18.87	18	17	17
600	1 940 207	18.10	17	16	16
700	1 976 732	17.32	16	15	15
800	2 013 257	16.53	16	15	15
900	2 049 782	15.76	15	14	14
1000	2 086 307	14.98	14	13	13
1100	2 122 832	14.21	13	12	12
1200	2 159 357	13.45	12	11	11
1300	2 195 882	12.68	12	11	11
1400	2 232 407	11.90	11	10	10
1500	2 268 932	11.14	10	9	9
1600	2 305 457	10.36	9	8	8

ANNEX 6

A list of solutions for the zodiacs from Athribis under less strict conditions

In order to verify the stability of the exhaustive astronomical solution as found for the zodiacs from Athribis in CHRON3, Chapter 18, in relation to possible variations in their decipherment, we have conducted a series of additional astronomical calculations under less strict interpretation conditions. Namely, we allowed for random order of planets inside planetary groups located in the solar vicinity. Apart from that, we have made the stipulations for the disposition of such planets across constellations a lot less rigid. However, we found no new exhaustive solutions for the Athribis zodiacs.

This means that the complete solution as discovered for the zodiacs from Athribis by the authors (15-16 May 1230 A.D. for the Upper Zodiac, and 8-11 February 1268 A.D. for the Lower) is resilient to the influence of significant variations in the decipherment of the zodiacs, which makes the solution a great deal more reliable.

Below we provide detailed lists of astronomical datings discovered for the Athribis zodiacs under substantially more lax interpretation conditions – namely, the following:

In case of the Upper Zodiac, we shall look for each and every solution with random order of planets inside the compact group found underneath Taurus, disregarding the conditions of their visibility from the Earth. This group consists of the Sun drawn as a circle, Mercury as a two-faced man with a rod, and another planet drawn as a bird. We ascribed the number 4 to the last planet in CHRON3, Chapter 18:7.1. It is identified as different planets in different interpretations – Jupiter, Saturn or Mars, qv in CHRON3, Chapter 18:1.1.

In the Lower Zodiac of Athribis we also find a compact group of planetary figures that includes the Sun. There are four of them this time, forming a line under three constellations – Capricorn, Aquarius and Sagittarius. Bear in mind that in our calculations we only allowed for random order of invisible planets, qv in CHRON3, Chapter 18. The Sun would naturally be considered as such, seeing as how we're referring to nocturnal celestial observations when the Sun is below the horizon.

This time we shall be more inclusive and consider the solutions with random planetary order inside the group. Moreover, we shall allow for the possibility that the symbols grouped closely around the solar circle refer to members of a single near-solar group. That is to say, individual planets from said group don't necessarily have to be located in the zodiacal constellations drawn above them. In other words, the near-solar planets shall only be linked to constellations by proxy of the Sun, the assumption being that

the author of the Athribis zodiacs had only made an effort to provide accurate ecliptic coordinates in case of the Sun, simply drawing the figures of the three other planets nearby, paying no attention to the constellations above them.

It has to be noted that this approach doesn't change anything in case of the Upper Zodiac, since we find all the near-solar planets under one and the same constellation of Taurus. However, the conditions for decipherment will become a lot less strict in case of the Lower Zodiac, since each of the three near-solar planets can wind up in any point of three constellations – Capricorn, Aquarius and Pisces, whose signs we find above the entire group of near-solar planets.

Another explanation for this *laissez-faire* approach to the interpretation of the Lower Zodiac from Athribis (far-fetched to a certain extent) is assumed insufficiency of space under the solar circle for the purpose of placing all three planetary figures there; this might be the reason why the planets had to be drawn on the sides of the Sun. This could place them in other constellations.

The corresponding input data files can be found in Annex 4 (see data codes AVA, AVB, AVC, AVD, AVE and AVF for the Upper Zodiac of Athribis, and data codes ANO, ANP, ANO, ANR, ANS and ANT for the Lower. As before, the time interval chosen for calculations spans the period between 500 B.C. and the present. The tables below contain full datings of all the solutions, also specifying planetary order in every case. Asterisks mark concurrence between the planetary order specified in the zodiac and the one suggested by the solution. Planets in parentheses were invisible because of their close propinquity with the Sun.

The system used for counting the years before Christ is astronomical and not historical. For instance, the year -244 refers to 245 B.C.

All the datings, the post-1582 ones included, are given according to the Julian calendar (or the "old style"). The reason is that accounting for the calendar leap in 1582 shall only introduce unnecessary complications into the computations. The readers can easily convert Julian dates into Gregorian ones, should they so desire. Both styles coincide in cases of the pre-1582 dates.

The abbreviation "Avg. dev." refers to the average deviation of the planets from their respective "best points" in arc degrees. See CHRON3, Chapter 16:11 for more on "best points". In case of the Lower Zodiac, the average deviation was calculated in relation to individual best points, including those for planets from the group found under Capricorn, Aquarius and Pisces. We chose the following best points: 9.5 for planet #3, 10.0 for the Sun, 10.5 for Venus and 11.0 for Mercury.

INTERPRETATION A1

The Upper Zodiac of Athribis Data code: AVA	*The Lower Zodiac of Athribis Data code: ANO*
Year -244, 21-23 May Avg. dev. = 14 Mars Sun Mercury*	No solutions
Year 76, 24 April. Avg. dev. = 17 (Mercury Sun) Mars	
Year 373, 10-11 May Avg. dev. = 8 Mercury (Mars Sun)	
Year 990, 27-28 May Avg. dev. = 7 Mercury (Sun Mars)	
Year 1227, 20 April Avg. dev. = 17 Sun Mercury Mars	
Year 1227, 18 May Avg. dev. = 13 Mercury Sun Mars	
Year 1345, 3 June Avg. dev. = 13 Mercury Sun Mars	
Year 1844, 8 May Avg. dev. = 8 Sun Mercury Mars	

Year 1962, 21-22 May Avg. dev. = 13 Mars Sun Mercury *	

Thus, identification A1 doesn't yield a single pair of datings for the Athribis zodiacs, even under less strict interpretation conditions.

Interpretation A2

The Upper Zodiac of Athribis Data code: AVB	*The Lower Zodiac of Athribis Data code: ANP*
	Year -406, 5-7 February Avg. dev. = 13 Mars Venus Mercury Sun
	Year 211, 28-29 January Avg. dev. = 11 Venus Mars Sun Mercury
	Year 271, 26 January Avg. dev. = 15 Mars Sun Mercury Venus
Year 408, 13 May Avg. dev = 19 Saturn Sun Mercury*	Year 448, 18-20 January Avg. dev = 10 (Mars Venus Sun) Mercury
	Year 448, 14-16 February Avg. dev. = 13 Mars (Mercury Sun Venus)
	Year 1065, 3-4 February Avg. dev. = 9 Venus (Sun Mars) Mercury
	Year 1125, 31 Jan – 1 Feb Avg. dev. = 8 Mars Sun Venus Mercury
	Year 1302, 25-26 January Avg. dev. = 13 (Sun Mercury Mars) Venus

Interpretation A2 yields no new solutions under less rigid conditions. The one we see here (408 and 448) already came up and was studied in CHRON3, Chapter 18. As we recollect, it was rejected due to poor correspondence between the planetary positions and the Upper Zodiac as well as incomplete correlation to the secondary horoscope of summer solstice in the Lower Zodiac.

Interpretation A3

The Upper Zodiac of Athribis Data code: AVC	*The Lower Zodiac of Athribis Data code: ANQ*
	Year -292, 5-8 February Avg. dev. = 10 Jupiter Mercury Sun Venus
Year -447, 16-17 May Avg. dev = 14 Mars Sun Mercury*	
Year 170, 5-6 May Avg. dev = 7 Mercury Sun Mars	
	Year 1002, 12-14 January Avg. dev. = 18 (Venus Sun) Mercury Jupiter
	Year 1002, 9-10 February Avg. dev. = 19 Venus Mercury (Sun Jupiter)
	Year 1239, 1-2 February Avg. dev. = 18 Venus Mercury (Sun Jupiter)
Year 1938, 18 May Avg. dev = 13 Mercury Sun Mars	

As we see from the table, there isn't a single pair of reasonably close dates for the zodiacs from Athribis. The difference between the dates from the Upper and the Lower Zodiac exceeds 150 years at any rate.

Interpretation A4

The Upper Zodiac of Athribis Data code: AVD	*The Lower Zodiac of Athribis Data code: ANR*
Year -328, 10-11 May Avg. dev = 19 Saturn Sun Mercury*	
	Year 5, 24-26 January Avg. dev. = 10 Venus Mercury (Jupiter Sun)
	Year 242, 15-16 January Avg. dev. = 12 Mercury (Jupiter Sun) Venus
	Year 242, 11-12 February Avg. dev. = 13 Jupiter (Sun Mercury) Venus
Year 1262, 20-23 May Avg. dev = 6 Saturn Sun Mercury*	
	Year 1773, 5-6 February Avg. dev. = 17 Venus Mercury Sun Jupiter

As we can see, identification A4 doesn't give us a single solution for the Athribis zodiac. The difference between the closest datings of both zodiacs is 300 years at least, which is obvious from the table.

Interpretation A5

The Upper Zodiac of Athribis Data code: AVE	*The Lower Zodiac of Athribis Data code: ANS*
	Year -440, 24-25 January Avg. dev. = 13 Mars Venus Sun Mercury
	Year 177, 13-15 January Avg. dev. = 14 Mars (Mercury Sun) Venus
	Year 177, 10-11 February Avg. dev. = 10 Mars (Venus Sun) Mercury
	Year 237, 7-8 February Avg. dev. = 13 Mars Sun Venus Mercury*
	Year 414, 1-3 February Avg. dev. = 11 Venus Mars Sun Mercury
	Year 1091, 18-20 January Avg. dev. = 16 Mars (Mercury Sun) Venus
	Year 1091, 14-16 February Avg. dev. = 16 Mars Sun Mercury Venus
Year 1230, 15-16 May Avg. dev = 7 Sun Jupiter Mercury*	
	Year 1268, 9-10 February Avg. dev. = 8 Mars (Venus Sun Mercury)
	Year 1328, 6-8 February Avg. dev. = 12 Mars Sun Venus Mercury

The table can give us two new versions for the Lower Zodiac's dating, while that of the Upper Zodiac shall remain the same:

1) 1230 for the Upper Zodiac and 1091 for the Lower;

2) 1230 for the Upper Zodiac and 1328 for the Lower.

Both these solutions are but modifications of the exhaustive solution that we came up with for the zodiacs of Athribis. On the other hand, both of them blatantly violate the order of clearly visible planets in the Lower Zodiac, and therefore cannot be regarded as valid solutions of the Athribis zodiacs.

Interpretation A6

The Upper Zodiac of Athribis *Data code: AVF*	*The Lower Zodiac of Athribis* *Data code: ANT*
	Year -452, 10-11 January Avg. dev. = 10 (Saturn Sun Venus) Mercury*
	Year -452, 5-7 February Avg. dev. = 12 Saturn Mercury (Sun Venus)
Year 79, 21-22 May Avg. dev = 15 Jupiter Sun Mercury*	
	Year 224 25-27 December Avg. dev. = 16 (Sun Mercury) Saturn Venus
	Year 225, 21-23 January Avg. dev. = 8 (Saturn Sun Venus) Mercury*
Year 256, 12 May Avg. dev. = 19 Jupiter Sun Mercury*	
Year 459, 18 May Avg. dev = 12 (Mercury Sun Jupiter)	Year 462, 7-10 February Avg. dev = 14 Venus Mercury Saturn Sun
Year 696, 9-10 May Avg. dev = 6 Mercury (Sun Jupiter)	Year 462, 4-6 January Avg. dev = 17 (Venus Sun) Mercury Saturn
	Year 699, 31 Jan – 2 Feb Avg. dev. = 10 Mercury (Sun Venus) Saturn
	Year 842, 11 February Avg. dev. = 19 Saturn (Sun Mercury) Venus
Year 1313, 26-29 May Avg. dev. = 10 Mercury (Sun Jupiter)	
Year 1847, 2-3 June Avg. dev. = 15 (Sun Jupiter) Mercury	

Apart from the pair of dates we already considered and rejected in CHRON3, Chapter 18:1.3 (256 and 225), we see two other pairs of close datings:

1) 459 for the Upper Zodiac and 462 for the Lower;

2) 696 for the Upper Zodiac and 699 for the Lower.

However, both of them manifestly fail to correspond with the order of visible planets specified in the Lower Zodiac. Moreover, both dates are mediaeval.

Thus, there are no solutions for the zodiacs from Athribis to be found anywhere near the beginning of the new era, which is the epoch that the Scaligerite researchers date them to, their trust in consensual ancient Egyptian chronology infallible ([1340:2]). Apart from that, we discovered that the abovementioned variations in the decipherment of the Athribis zodiacs don't give us a single exhaustive solution whose precision would approximate the one that we discovered.

ANNEX 7

A more precise drawn copy of the Greater Zodiac of Esna performed by the authors of the present book in Egypt and based on the original

In July 2002 G. V. Nosovskiy, one of the authors of the present book, visited the city of Esna in Egypt as a member of the expedition organised by the "Unknown Planet" television programme staff. He has used this rare opportunity to make a complete and detailed photographic copy of the Greater Zodiac of Esna in its modern condition – possibly, the very first series of detailed colour photographs of this unique and exceptionally important artefact ever (the previously available copy was drawn by Napoleon's artists in the beginning of the XIX century, qv in [1100]).

G. V. Nosovskiy has meticulously photographed the entire ceiling surface of the Greater Temple of Esna – in particular, the complete Greater Zodiac of Esna. We have also used other photographs of the Greater Zodiac of Esna, taken at our request and most kindly put at our disposal by Y. L. Maslyayev, a professional photographer, another member of the expedition.

Then in 2006 G. V. Nosovskiy visited Esna once again, and, using a more powerful flash, once again photographed all the parts of the Greater Zodiac of Esna, which turned out insufficiently brightly lit in the photographs of 2002. The matter is that the ceiling of the temple is rather high and some parts of it are entirely void of lighting, which is why one needs a powerful professional flash to make quality photographs of the entire surface of the ceiling. The photographs of 2002 and 2006 gave us the opportunity to study the Greater Zodiac of Esna to the minor detail.

We must emphasise that the photographs have covered the entire surface of the Greater Zodiac. It turns out that the zodiac didn't lose any details over the 200 years that have passed since the Napoleonic expedition. It has survived until our very epoch, with all of its details intact. We have finally been given a unique opportunity of verifying the correctness of the "Napoleonic drawn copy" of the Greater Zodiac of Esna, which served us as the basis for a detailed research and dating in 2001, qv in "Stars", part 2 (we occasionally use the abbreviation EB for referring to this zodiac). Now we can correct the imperfections inherent in the "Napoleonic edition" ([1100]) and verify the correctness of our dating. Let us inform the reader right away that although we have found a number of defects in the "Napoleonic" drawn copy, they haven't affected the result of the astronomical dating. Moreover, after the correction of the "Napoleonic" inaccuracies, the correspondence between the zodiac in question and its exhaustive astronomical solution (namely, 31 March – 3 April 1394) has only become better. A couple of oddities inherent in the Greater Zodiac of Esna, which we pointed out in 2001 after our analysis of the "Napoleonic" drawn copy, have disappeared (more on this below). The oddities in

question were simply a result of the errors made by Napoleon's artists.

A corrected drawn copy of the Greater Zodiac of Esna with corrections of all the defects inherent in the "Napoleonic" copy can be seen in figs. d1, d2 and d3. Let us note that most defects were found in the places obscured by the top parts of the columns supporting the temple's dome. The columns of the Greater Temple of Esna conical top parts, widening rather conspicuously towards the top, which hides a part of the ceiling from the observer below. However, if the observer moves to a different place, it will be possible for him to see a part of the ceiling artwork that was obscured. Thus, by changing the observation location a couple of times, one might eventually see the whole of the Zodiac. But one must move around constantly, which must have been rather difficult for the artists who copied the Zodiac for the "Napoleonic" album. It is perfectly understandable that they made mistakes in the very places that were obscured by the top parts of the columns. Fortunately, the defects were not grave enough to get in the way of the astronomical dating.

This "good fortune" is far from random – in 2001 we took into account all the secondary horoscopes of the Greater Zodiac of Esna as well as its primary horoscope. As a result, the sum total of dating information employed in the process proved sufficient for an "automatic compensation" of the minor imperfections inherent in the "Napoleonic" copy of the Zodiac that we had had at our disposal.

Let us provide a brief description of the "Napoleonic" copy's primary defects.

1) The figure of Virgo in the "Napoleonic" album was touching the tail of the lioness with a human face in front, as though they were forming a single symbol, very similar to the symbol of Leo as used in certain Egyptian zodiacs. In 2001 we were forced to make a lengthy explanation of why they should be regarded as two separate symbols bearing no relation to Leo (namely, the constellation of Virgo and a secondary horoscope figure). In reality, as it became clear from our photographs of the Zodiac, the fact that Virgo stands so close to the leonine figure from one of the secondary horoscopes happens to be an oversight from the part of the "Napoleonic" artists – in reality, the Zodiac makes a clear distinction between the two, qv in fig. d1.

2) The man who holds a knife raised above his head as seen in Zodiac EB (over Leo, next to the "auxiliary figure" of Virgo, held a rod in his right hand as per the "Napoleonic" copy. This is why we considered two identification options for this figure in the corresponding secondary horoscope in 2001, namely, Mars (militant planet) and Saturn (sinister planet). It turns out that the man is actually holding a bow and arrows in his right hand and not a rod (fig. d2). Therefore, the figure in question represents Mars. This is in ideal correspondence to the astronomical solution that we have discovered.

3) In the Napoleonic drawn copy there was a human figure between Taurus and Aries. We had to make the assumption that it was an auxiliary symbol of the Moon. It contradicted nothing astronomically; however, we have encountered no auxiliary lunar figures of this sort in any other Egyptian zodiac. Therefore, the figure in question looked extraneous. This part of the Zodiac is obscured by the top of the column; its visibility is very poor. No XIX century artist could have used this kindof lighting; therefore, the possibility of his making an error was very high. This is indeed the case.

As the photographs demonstrate, the human figure that we see here is situated in a manner that differs from that of the Napoleonic artists substantially (see fig. d2). The actual figure was drawn correctly, but his zodiacal disposition was wrong, hence our initial confusion in this zodiac's decipherment. In reality, this human figure has got absolutely nothing to do with the general set of drawings that comprises the planets of the primary and the secondary horoscope. All planetary figures seem to be walking on the ground. As for the figure in question, it is hanging upside down high above the earth. It is easy to notice that the neighbouring figure of the Taurus constellation is situated similarly (fig. d2). The human figure in question can now be regarded as incumbent right above Taurus, and not standing or hanging. Taurus hangs upside down and obviously constitutes a pair of related symbols together with the above figure, which is emphasised in the zodiac.

We can instantly recollect another incumbent figure of this sort, also in Taurus – it is present in the Lesser Zodiac of Esna, qv in fig. 6.47 in [NCE]. We discussed it in detail in our study of the Lesser Zodiac

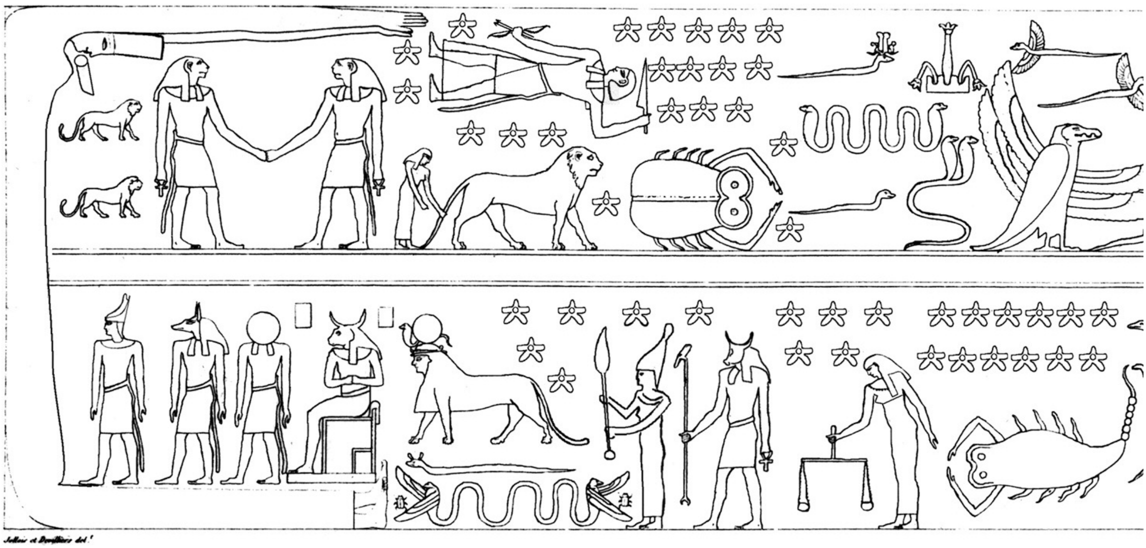


Fig. d1. Our corrected drawn copy of the Greater Zodiac of Esna (EB). It is a corrected version of the "Napoleonic" drawn copy ([1100]), A. Vol. I, PL. 79 made with the aid of the photographs taken by Y. L. Maslyayev and G. V. Nosovskiy in July 2002 in the Greater Temple of Esna. All the errors of the "Napoleonic" copy capable of affecting the decipherment have been corrected. First part of the drawing.

([NCE]). The figure symbolises dead Osiris laying in a coffin. In the Lesser Zodiac of Esna it is part of the symbolic representation of the Christian Easter, qv in [NCE]. Here we see the very same figure of the dead Osiris, also in Taurus, but without any corresponding symbols of Easter this time.

Therefore, the human figure between Taurus and Aries isn't anything in the way of a planetary symbol, as our initial impression suggested (based on the error of the Napoleonic artists, who had rotated it by 180 degrees and put it in the same row as the planetary symbols. It becomes obvious that this figure is an auxiliary symbol which can simultaneously be associated with both the Taurus constellation and the resurrection of Osiris. Its meaning becomes completely clear in the light of our research as related in our books "King of the Slavs", "The Baptism of Russia" and "Jerusalem the Forgotten".

None of the above affects the problem of astronomical dating directly, we have to clarify our point. We refer the reader to the above books for all the details. We must also point out that our reconstruction is of a hypothetical nature so far; however, all of the dates that we cite below are precise, and their veracity has been proved by several independent natural scientific methods.

Our reconstruction is as follows. Osiris is the "ancient" Egyptian name of Christ. The Crucifixion of Jesus Christ took place on Friday 22 March 1185 on Mount Beykos (also known as Mount Youshi – the Mount of Jesus, in other words). It is situated on the Asian coast of the Bosporus, right next to the Black Sea. Christ resurrected on Sunday 24 March 1185. Shortly afterwards, on 1 May 1185 a total eclipse of the Sun took place in the constellation of Taurus, whose track covered the Vladimir and Suzdal part of Russia. The Russians could observe this eclipse around the time they learnt the news of Christ's crucifixion. Christ was already a well-known figure in Russia, since his mother Mary was from Russia originally. Christ spent many years in Russia prior to his becoming a king in Czar-Grad and the subsequent loss of throne and crucifixion. The ancient Czar-Grad of the XII century can also be identified as the Evangelical Jerusalem (Yerosalim). The name is borne to this day by the deserted citadel of Yoros on the Asian coasts of the Bosporus, next to the "Mount of Jesus" on the Asian coast of the Bosporus, about 30 kilometres away from Istanbul.

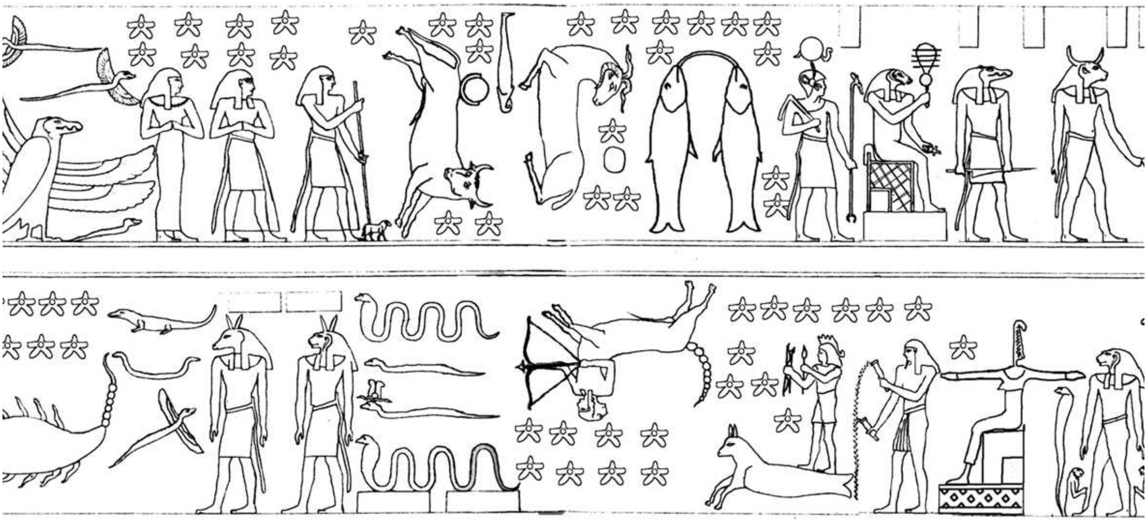


Fig. d2. Our corrected drawn copy of the Greater Zodiac of Esna (EB). Second part of the drawing.

It is little wonder that the Russians directly associated the solar eclipse in Taurus of 1 May 1185 A.D. with the crucifixion of Christ. Later on, certain ecclesiastical authors, such as Dionisius Areopagis, started to make the false claim that the solar eclipse took place on the very day of the Crucifixion, which is an astronomical impossibility, seeing as how Christ was crucified on a full moon (see "King of the Slavs").

Apart from that, the supernova whose explosion's remnant is now known as Crab Nebula, flared up around 1150 A.D., also in Taurus. It is the famous Evangelical "Star of Bethlehem" that heralded the birth of Christ. See our book entitled "King of the Slavs" for more details concerning the explosion of this supernova.

Thus, the two vivid astronomical events directly associated with the birth, the death and the crucifixion of Christ by his contemporaries took place in the constellation of Taurus. Therefore, we find figures that symbolise the death and the resurrection of Osiris in Taurus and not any other constellation.

The reader might wonder why the symbols of Osiris, or Christ, are only found on the zodiacs of Esna and absent from many other zodiacs of the Ancient Egypt? Our reconstruction as related in our book entitled "The Baptism of Russia" suggests a plausible answer. According to the results of our research, the epoch of baptism into Apostolic christianity under Constantine the Great, which Scaligerian chronology dates to the IV century A.D., happens to be the epoch of the late XIV - early XV century, which postdates the Scaligerian version by some 1000 years. However, the datings of both zodiacs found in Esna (1394 and 1404 A.D.) fall right over this epoch. Thus, according to our reconstruction, the zodiacs of Esna are some of the very first apostolic and Christian zodiacs of the ancient Egypt, which makes their symbolism somewhat specific. In particular, this refers to the symbolic representation of the Christian Easter in the Lesser Zodiac of Esna and the symbol of Christ, or Osiris, in Taurus on the Greater Zodiac of Esna.

4) On the "Napoleonic" copy both figures sitting on chairs to the right of Pisces at the edge of the Zodiac, in the top right corner, were female. This is why we were forced to associate both figures with the "female" planet Venus. However, the man with a rod following the rightmost of the two sitting figures must have represented Jupiter or Mars – a male planet (the complete solution confirms it to be Mars). As a result, Mars ended up without any corresponding sitting figure – this is rather odd, since such figures accompanied all the other planets in the Greater Zodiac of Esna except for the Sun and the Moon.

As it turns out, the "Napoleonic" copy contained

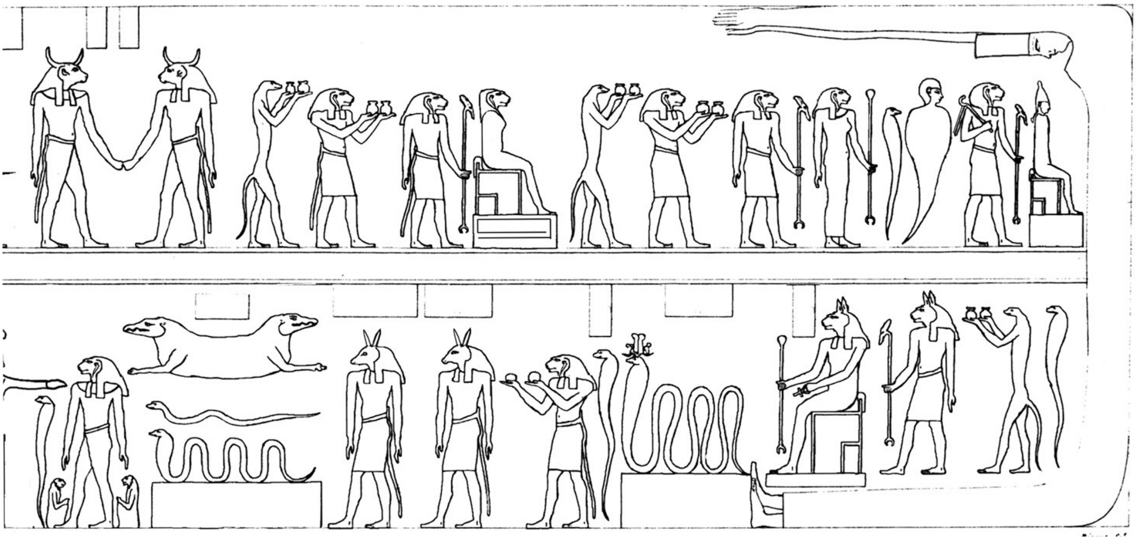


Fig. d3. Our corrected drawn copy of the Greater Zodiac of Esna (EB). Third part of the drawing.

another error. In reality, the rightmost sitting figure found to the right of Pisces is male and not female (see fig. d3). Therefore, it must be associated with a "male" planet and not Venus – Mars in the present case. All the pieces fit at once.

5) The figure sitting on the chair to the right of Aquarius (with a feather instead of a head) was male in the "Napoleonic" copy. This led to certain complications in decipherment. Due to the male sex of this figure, we had to associate it with Mercury; the latter received two sitting auxiliary figures as a result, the meaning of which wasn't very clear. Now it is obvious that the "difficulty" is merely a result of an error made by the "Napoleonic" artists. In reality, the figure is female and not male. Our photographs make this fact perfectly obvious (see fig. d3). In this case, the symbol in question shall be unrelated to Mercury, and each of the five planets seen in Zodiac EB (Saturn, Jupiter, Mars, Mercury and Venus) shall end up with a single auxiliary figure each, which will make the zodiac look a great deal more natural.

The meaning of the sitting female figure with a feather instead of a head (to the right of Aquarius) also becomes quite clear. Its hands, stretched in two directions, are most likely to stand for the equal durations of day and night, which makes the figure another auxiliary symbol of the vernal equinox, united with the symbols of Venus and Mercury (female figure and the feather head). Let us recollect that the Greater Zodiac of Esna has another (primary) vernal equinox symbol, which we see a little to the right from Pisces – two male figures with crescent-shaped horns on their heads holding hands (see CHRON3, Chapter 15, section 8.3).

The meaning of this auxiliary vernal equinox symbol in said part of the EB zodiac is perfectly obvious – it separates the procession of Mercury from Aquarius and "ascribes" it to Pisces (the location of the vernal equinox point, qv in Chapter 15, section 8.3). Otherwise, the procession of Mercury, located in the lower row of the Zodiac, would more likely relate to Aquarius (the closest constellation) and not Pisces, which is located in a different row. In 2001 we considered this option in our dating – however, the exhaustive astronomical solution placed Mercury in Pisces and not Aquarius (CHRON3, Chapter 17, section 5). Now it has become clear that the circumstance in question was emphasised in the Zodiac by its creators, but has managed to evade our attention because of an error made by the Napoleonic artists.

Thus, according to our more precise drawn copy, three planets (Mercury, Mars and Venus) were depicted in the EB zodiac inside "equinox parentheses" of sorts – between two symbols of the vernal equi-

Fig. d4. The procession of Jupiter or Mars (it has to be said that, according to the exhaustive astronomical solution, the planet in question is none other but Jupiter) in the Greater Zodiac of Esna. Left to right: one of the Piscean figures (the second one cannot be seen here), the primary figure of Jupiter with a rod, the auxiliary figure of "sitting Jupiter", the leading figure in the procession of Jupiter with the head of a crocodile and a knife in its hand, the primary spring equinox symbol (two male figures with bovine heads holding hands), two figures from the end of the Venus procession (one of them is only partially visible). The white spots visible in the photograph are the traces of bat faeces. The photograph was taken by Y. L. Maslyayev and G. V. Nosovskiy in Esna, Egypt, July 2002.

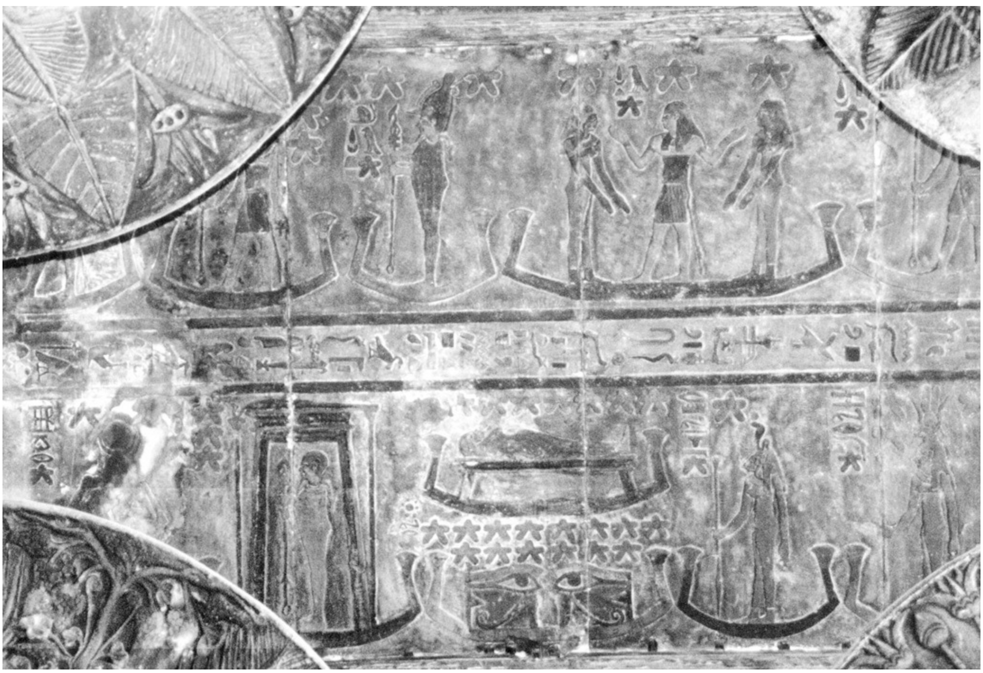


Fig. d5. Fragment of the ceiling from the Greater Temple of Esna. Below we see the scene of Osiris dying and resurrecting on the 14th moon, identical to the one found in the Lesser Zodiac of Esna (cf. fig. 15.71). We see a symbolic "ancient" Egyptian rendition of the astronomical conditions for the Christian Easter feast. The photograph was taken by G. V. Nosovskiy in Esna, Egypt, July 2002.

nox, or in Pisces. This is exactly what the complete astronomical solution of 1394 A.D. is telling us.

Possibly, the attribution of the planetary symbolism of Venus and Mercury (female figure and the feather) to the auxiliary spring equinox symbol indicated close proximity between the planets in question near the vernal equinox point in Pisces.

Let us point out another oddity, which has resolved itself after the new photographs were made. The "Napoleonic" copy mixed the "procession of Venus" with the "procession of Mars"; however, the "procession of Mercury" remained separated from the two for some reason, which set Mercury apart from Venus and Mars. However, in the exhaustive solution of 1394 all three planets have come very close to each other – Venus, Mars and Mercury. Therefore, there were no astronomical reasons to set the procession of Mercury apart from the processions of Venus and Mars. Now we see no such distinction took place. On the contrary – all three planets were included in a common set of "equinox parentheses" by the creators of the Zodiac.

It must be noted that Jupiter was drawn outside the "equinox parentheses" in question, albeit it was in Pisces as well – this is in perfect correspondence with the exhaustive astronomical solution of 1394, where Jupiter stands apart from a very tight group of three planets – Mars, Mercury and Venus. All four planets were located in Pisces (a very large constellation that occupies a substantial amount of space on the ecliptic).

6) The male figure on the right of Pisces was erroneously drawn without a planetary rod by the Napoleonic artists. As a result, when we were deciphering the EB zodiac in 2001, we had to make the assumption that the primary figure of the corresponding male planet (Jupiter or Mars; it turned out to be Jupiter in the exhaustive solution) is the figure on the right holding a planetary rod. However, this figure turned out to be accompanying the sitting Venus (the second figure on the right of Pisces) and not its own sitting figure (the first one on the right of Pisces). It was so strange that we even came up with a hypothesis that the rod was missed out for some reason. However, without precise photographs we could not confirm our suspicion. Now it has turned out that the Napoleonic artists did in fact omit the rod.

The correction of this error eliminated the abovementioned oddity in the decipherment of the Greater Zodiac of Esna (see figs. d3 and d4). As we assumed initially, the primary figure of Jupiter is the male figure with a planetary rod to the right of Pisces. The figure with a planetary rod and a leonine head right next to Venus on a chair pertains to the procession of Venus and not Jupiter, as we were forced to assume due to the error inherent in the "Napoleonic" copy. None of the above affects the decipherment of the Zodiac in any substantial way; however, it becomes more understandable and natural.

7) Male figure standing on the back of Capricorn was holding the symbol of summer solstice in its hands, which was rather odd. In reality, it was an error of Napoleon's artists. The male figure is holding a bow and some arrows, and not a solstice symbol (see fig. d2.). Furthermore, it is wearing a soldier's helmet, which was altogether omitted by the authors of the Napoleonic artists. This identifies the figure as Mars, the "militant" planet. We could not possibly discover this in our decipherment of 2001, since all the attributes of Mars were omitted or replaced in the "Napoleonic" copy.

Now it becomes clear that the figure in question stands for none other but Mars in the secondary horoscope of winter solstice. The figure stands on the figure of Capricorn, which serves as a "transposition symbol" (see CHRON3, Chapter 15, section 6). In other words, it is part of a secondary horoscope and bears no relation to the primary.

Indeed, Mars was next to the Sun in the secondary horoscope of winter solstice (for the exhaustive solution of 1394). On the actual day of solstice Mars was in Sagittarius, next to the Sun and therefore rendered invisible by the bright sunshine. A month and a half later it emerged in the visibility zone, already in Capricorn. In 2001 our use of a defective copy led us to the assumption that Mars wasn't made part of this secondary horoscope because of its invisibility. It turns out that the creators of the Zodiac portrayed it as a militant male figure standing on the figure of Capricorn. This fact is in complete correspondence with the astronomical solution of 1394. It has to be pointed out that the invisibility of Mars may have confused the ancient observer about the exact position of the planet in question (the constellation of

Sagittarius or Capricorn). It is possible that Mars was indicated in Capricorn due to its visibility in said constellation, whereas it wasn't visible at all in Sagittarius.

There are several other minor discrepancies between the "Napoleonic" drawn copy and our photographs of the Greater Zodiac of Esna. All of them have been accounted for in the corrected drawn copy, qv in figs. d1, d2 and d3.

In general, one might say that after the correction of the discrepancies we discovered, the correspondence between Zodiac EB and its exhaustive astronomical solution of 1394 became even better. Before the correction of the Greater Zodiac's symbolism there were a number of oddities that we considered to be the zodiac's idiosyncrasies. These oddities have disappeared; the decipherment of the Zodiac has remained the same.

Another thing to note is as follows. Our study of the photographs suddenly revealed that there is a symbolical representation of the Christian Easter feast upon the ceiling of the Greater Temple of Esna, similarly to the Lesser Zodiac of Esna (see Chron3, Chapter 15, section 9.1 and Chapter 17, section 6.7). A photograph of this part of the ceiling can be seen in fig. d5. Compare to fig. 15.71 of the present volume.

In fig. d5 below we see the already familiar symbol that looks like a pair of Egyptian "eyes" facing each other. In this particular case they stand for the Moon and also symbolise the resurrection of Osiris (see Chron3, section 15.9.1). Right above the pair of eyes we see 14 stars. Therefore, the moon was full, with 14 days of age (in mediaeval Christian tradition, full moon was known as "14th moon", qv in Chapter 19 of "The Biblical Russia". Further up, over the stars, we see the boat with the dead Osiris. The meaning of the whole scene is perfectly obvious – Osiris dies to resurrect when the moon is full, or "on the 14th Moon". This is a precise astronomical description of the Christian Easter, or feast of Christ's resurrection. See Chron3, Chapter 15, section 9.1 for more details.

It has to be noted that previously we only saw the Christian Easter scene in the Lesser Zodiac of Esna (see 15.71). Now it turns out that it is also present on the ceiling of the Greater Zodiac of Esna, right next to Zodiac EB.

This fact makes the symbol sets of both Esna zodiacs, which happen to be in good correspondence already, even closer to each other. This fact is also in ideal concurrence with the circumstance that the dates transcribed in the two zodiacs of Esna turned out to be very close to each other – namely, 1394 for the Greater Zodiac and 1404 for the Lesser Zodiac of Esna, qv in Chron3, Chapter 17, sections 5 and 6.

Let us conclude by citing our complete drawn copy of the Greater Zodiac of Esna (fig. d6).

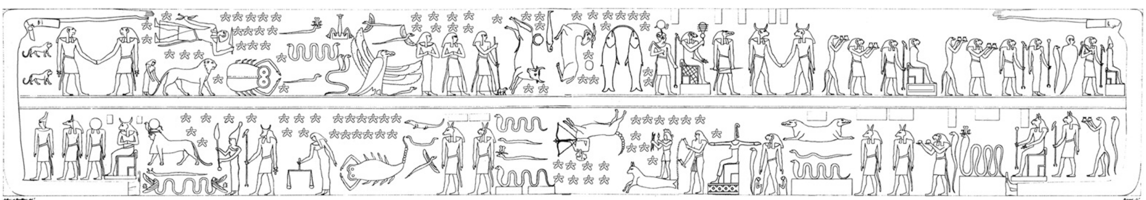


Fig. d6. Our complete corrected drawn copy of the Greater Zodiac of Esna made with the aid of the photographs taken in July 2002.

ANNEX 8

Our replies to the authors of certain erroneous works, who tried to refute our astronomical datings

To Academician N. A. Plate, Editor-In-Chief of the "Vestnik Rossiyskoi Akademii Nauk" journal, a periodical edition published by the Russian Academy of Sciences

Dear Nikolai Alfredovich,

You have given a negative answer to my request to publish my open letter to Academician Y. S. Osipov with a response to his criticisms in the "Vestnik Rossiyskoi Akademii Nauk" journal. Instead, you suggested that an article be written in re the publication of Y. N. Yefremov and Y. A. Zavenyagin, with a foreword by V. L. Ginzburg. Said article was published in the "Vestnik's" 12th issue for 1999 (pages 1081-1082). I am enclosing a reply to this publication with a request to publish it in your journal.

Very truly yours,

Academician A. T. Fomenko,

21 March 2000.

A reply to the publication of Y. N. Yefremov and Y. A. Zavenyagin with a foreword by Academician V. L. Ginzburg, which was published in the "Vestnik Rossiyskoi Akademii Nauk" in 1999, issue 12

A. T. Fomenko and G. V. Nosovskiy

The article of Y. N. Yefremov and Y. A. Zavenyagin objects to our dating of the Almagest star catalogue ([m1] and [m2]) for the following reasons:

1. The authors disagree with our observation that the initial longitudinal reference point of the Almagest catalogue is prone to a certain ambiguity. Half of their article's section entitled "The Almagest and its Dating" is concerned with a discussion of this issue. This is also the subject of the second accusation in the list that one finds on page 1088 (article [m13]).

Our reply. Our method of dating the Almagest star catalogue does not refer to the position of the longitudinal reference point anywhere. Our observation in re the point in question, which was cited in our book ([m1] and [m2]), serving Y. N. Yefremov and Y. A. Zavenyagin as the impetus for their verbose commentary, happens to be of no significance whatsoever inasmuch as our method of dating is concerned.

We have actually performed the dating of the Almagest by longitudes and proper motion rates in [m2], pages 176-178. However, its precision turned out to be substantially lower than that of the latitudinal dating for the simple reason that the Almagest longitudes are less precise than latitudes, which must be known perfectly well to Y. N. Yefremov and Y. A. Zavenyagin. Their claims about us rejecting the longitudinal dating are therefore completely misleading (see [m13], page 1083).

As for the precession-based dating of the catalogue, we consider it in section 2 below.

This is the only actual direct "objection" against our dating of the Almagest catalogue that one finds in the article ([m13). All the other objections are of an indirect nature and come up to the following: "your dating cannot be correct since we believe that other calculations, not based on the Almagest cata-

logue in any way, contradict it". See Section 2 for more on this subject.

2. Y. N. Yefremov and Y. A. Zavenyagin point out the discrepancies between our work and the works of different researchers who have tried to date the Almagest and other old astronomical data, as well as the respective dating results. The following examples are given.

2a. Precession-based longitudinal dating of the Almagest catalogue yields the I century A.D. as a result.

2b. Star declination dating yields the beginning of the new era as a result (see accusation #5 on page 1088 in [m13]).

2c. Babylonian astronomical documents "doubtlessly confirm the antiquity of the ancient history" ([m13], page 1088 – see accusation #1 on page 1088 of [m13]).

Our reply. We have deliberately sought such methods of dating the Almagest that would be based on astronomical characteristics and principles unknown until the XVIII century. The justification of this methodology is a separate issue that we cannot discuss presently. At any rate, we have voiced this principle with enough precision and in perfectly explicit terms in our book ([m1] and [m2]) and implemented it consecutively. This is why we didn't use either star declinations or positions of the Sun for dating purposes, let alone longitudinal precession. All such characteristics and resulting dates may well have been employed by XVII century astronomers in their calculations (and their rather remote predecessors were already capable of using longitudinal precession for the same end). We know that data of this kind yield dates that concur with the Scaligerian version. Our discovery is that the use of other data, the kind that cannot be a product of XVII century calculations by default, gives altogether different dates. Therefore, the "objections" of Y. N. Yefremov and Y. A. Zavenyagin are merely a demonstration of their incapacity (or reluctance) to understand the general principles of our approach.

As for the "Babylonian astronomical records" – we deliberately refrain from discussing them in our book about the dating of the Almagest. It is an altogether different issue that requires an in-depth analysis – a mere passing reference very clearly will not do ([m13], page 1088). It has to be said that the researchers involved in the dating and the interpretation of such old documents are as a rule convinced that the traditional chronology cannot possibly be incorrect, and often rely on its implications – examples of such an approach exist in great abundance. The Babylonian tablets are no exception, either. We must once again note that the issue in question is of no relevance to our book about the dating of the Almagest catalogue.

3. Y. N. Yefremov and Y. A. Zavenyagin express their outrage about the fact that we do not use the calendar indications of months and days provided in the Almagest as they discuss our dating of planetary coverings of stars (accusation #6 on page 1088 in [m13]).

Our reply. The reason is the same as we specify in Section 2. The month and the day are de facto defined by the position of the Sun – a characteristic that might be a result of XVII century calculations. Also, the traditional interpretation of the month names inherent in the Almagest and their conversion into the modern calendar system is anything but obvious, and requires a separate discussion.

4. Y. N. Yefremov and Y. A. Zavenyagin appear to have comprehended nothing about our research that concerned calculating uniform systematic error areas in the Almagest catalogue. This is what they write: "The assumption that different catalogue copies were compiled by different observers happens to be one of Fomenko's main arguments in favour of choosing celestial areas that were allegedly observed better … contradicting all known information" ([m13], page 1086). This miscomprehension appears to have served as the basis of the third and rather vague accusation on page 1088 of [m13].

Our reply. Y. N. Yefremov and Y. A. Zavenyagin are making false claims by ascribing such assumptions to us – we never "assumed" anything of this sort. What Yefremov and Zavenyagin present as our "assumptions" are merely our explanations of possible (but by no means obligatory) reasons behind the statistical fact that the systematic error of the Almagest catalogue is non-uniform, as we have discovered. There may be different reasons behind this – different observers being just one of them. This may or may not have been the case; however, our method and our results are wholly independent from this circumstance. This "counter-argumentation" of Yefremov and Za-

venyagin looks rather odd and makes one wonder whether they actually understand the matter at hand.

5. We are particularly surprised by accusation 4 on page 1088 in [m13]. Y. N. Yefremov and Y. A. Zavenyagin write the following – we cannot help quoting this passage in its entirety: "Why do all the ancient catalogues, including the Arabic works, which have survived until our day and age, whose stellar coordinates were the very same Almagest coordinates converted to fit certain historical epochs, happen to hail from one and the same ancient epoch of the Almagest catalogue?" ([m13], page 1088). One wonders how Yefremov and Zavenyagin managed to access the drafts and intermediate calculations of mediaeval authors. It is perfectly obvious that their claims are based on their absolute trust in Scaligerian chronology, which spawns such corollaries.

6. Finally, let us consider the epilogue of Y. N. Yefremov, wherein he offers the reader his own version of dating the Almagest catalogue (co-authored by A. K. Dambis). Y. N. Yefremov refers to the two graphs one finds on page 1090, claiming them to represent his results. The first one corresponds to the dependency of the Almagest catalogue epoch on the number of stars used in calculation ordered by their proper motion rate values listed in descending order. The second is similar – it represents the dependency on the number of fast stars excluded from analysis ordered by their proper motion rate values listed in descending order. Intervals drawn around the "precise datings" are referred to as "square average discrepancy intervals" by Y. N. Yefremov. He is of the opinion that the intervals in question correspond to the error margin estimate for his method. This is directly implied by the text on page 1090. Even a cursory glance at the graphs reveals that the precision margin of "Yefremov's method" doesn't change in case of the first graph and changes very marginally in case of the second, once the fastest stars are excluded from calculations. How Yefremov and Dambis manage to date the Almagest catalogue with the precision of ± 400 years, having rejected 20 fastest stars, or all of the visibly mobile Almagest stars, remains a mystery. This is tantamount to dating the Almagest catalogue by the proper motion rates of immobile stars, or stars with virtually nonexistent proper motion rates. In the case of Y. N. Yefremov and A. V. Dambis considering all the Almagest stars, including the fastest ones, the precision of their dating is completely unrealistic – allegedly ± 100 years. Elementary estimates resulting from a division of the Almagest systematic error rate by the velocities of the fastest stars that can be reliably identified in the Almagest reveals that no smaller error margin than ± 300-350 years is possible in this case. Also, there are very few "fast" stars – a mere handful. The overwhelming majority of stars are all but immobile. Therefore, having excluded 20 fastest stars from their calculations, the precision estimate of the catalogue dating suggested by Y. N. Yefremov and A. V. Dambis shall equal ± several millennia. Y. N. Yefremov has already made a serious error in the estimate of his "method's" precision in [m12]. We have considered the error of Y. N. Yefremov in detail in our books [m1] and [m2] as well as the article [m5]. Nevertheless, Y. N. Yefremov manages to make the very same error. We must once again cite this very simple arithmetical calculation for Y. N. Yefremov and A. V. Dambis in order to demonstrate the absurdity of their precision claims for their attempt to date the Almagest catalogue by proper motion rates.

It is obvious that the precision of any dating method that refers to the proper motion rate of a fast star shall have its lower margin by the individual error in the estimation of said star's position in the Almagest divided by its proper motion velocity. Had there been an abundance of such stars (N items, for instance), we could raise the precision of our method employing division by roughly the square root of N. However, as we have already mentioned, there are very few fast stars in the Almagest catalogue, and the proper motion velocity rate falls very quickly. Therefore, the a priori known upper margin of the method's precision estimate shall be the calculation employing Arcturus, the fastest of the reliably identifiable stars. In general, one cannot use more than 20 Almagest stars for a proper motion rate dating, since the rest of them happen to be virtually immobile. Y. N. Yefremov de facto acknowledges this fact in the following passage: "All 1022 stars were used, the slow stars defining the coordinate system" ([m13], page 1089). In other words, slow stars are only useful for defining the coordinate system, but not the purposes of actual dating.

All the stars in the Almagest were measured with errata of some sort. This is doubtlessly true about the

slow stars that define the coordinate system of Y. N. Yefremov and A. K. Dambis. However, let us assume for a moment that the positions of slow stars are measured with ideal precision in the Almagest. Even in the ideal case we cannot assume the error in the Almagest estimate of the position of Arcturus to be smaller than 10' by either coordinate, since that is the value of a single step of the Almagest star catalogue coordinate scale. The real value of this margin is actually higher due to the imprecise coordinates of the neighbouring stars.

The arc distance error equals circa 14 arc minutes. If the possible error by each of the coordinates equals 10 arc minutes, it shall equal 14 arc minutes for the hypotenuse, according to the Theorem of Pythagoras. The annual proper motion rate of Arcturus equals circa 2 arc seconds. Thus, it takes Arcturus about 420 years to cover the distance of 14 arc minutes. The lower margin of ± is merely a rough estimate of the Arcturus dating precision with arc distances used in calculations, or latitudes together with the longitudes. The use of nothing but latitudes makes it possible to raise the method's precision somewhat and come up with the dating whose precision margin will equal ± 300 years. Dating the Almagest catalogue by proper motion rates of the stars it contains with any higher precision is impossible. The use of fast stars that cannot be identified reliably in the Almagest leads us to a vicious circle – such is the case with Omicron 2 of Eridanus, for instance.

The above makes the words of Academician V. L. Ginzburg that we find in his preface where he claims having finally encountered a "clear and precise analysis of A. T. Fomenko's errors" ([m13], page 1081) in the work of Y. N. Yefremov and Y. A. Zavenyagin. One cannot help wondering about the exact passage of the blatantly demagogical oeuvre concocted by Yefremov and Zavenyagin that struck Academician V. L. Ginzburg as "clear and precise", as well as whether or not he actually gave the problem in question any thought at all.

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by V. L. Ginzburg). *On the so-called "New Chronology" of A. T. Fomenko.* – "Vestnik RAN", 1999, Volume 69, #12, pages 1081-1092.

* * *

Our reply as given above was published in the "Vestik RAN", #9, 2000.

Our analysis of Y. N. Yefremov's article entitled "A New but False Chronology"

([p19], pages 142-146)

About one half of Y. N. Yefremov's article consists of biased emotional statements that reflect Y. N. Yefremov's absolute trust in the chronology of Scaliger and Petavius as well as the school course of history. For example, Y. N. Yefremov is of the opinion that "consensual chronology does not require any new proof or tests" ([p19], page 142). Furthermore, Y. N. Yefremov is convinced that historians "carry on publishing irrefutable proof with infinite politeness … but politeness is of little aid here" ([p19], page 142). This is the very reason why Y. N. Yefremov decided to abandon the etiquette common for scientific discussions and resolved to "call a spade a spade", as he claims on page 142 of [p19]. However, most articles contained in [p19] and [p20] are characterised by extreme coarseness, so Yefremov's article is by no means exceptional in the context of [p19] and [p20].

Let us point out the following "important evidence" that works in favour of the consensual chronology according to the opinion of Y. N. Yefremov – as an amusing oddity. We quote verbatim: "The spirit of an epoch has a unique taste. Virgil doesn't resemble Dante, Julius Caesar has got nothing in common with Charlemagne, and the Gothic cathedrals are quite unlike Parthenon. No discussion is needed [sic!] to realise they are separated by many centuries of humankind's evolution" ([p19], page 142). The logic of Y. N. Yefremov strikes one as twisted. For instance, the Cathedral of St. Basil the Divine on the Red Square and the Blagoveshchenskiy Cathedral of the Muscovite Kremlin look nothing like each other, but were nevertheless built in the same epoch. What is the source of Y. N. Yefremov's unswerving trust (he "needs no discussion", after all) in chronological heterogeneity (as in "separated by centuries of evolution") of buildings that fail to resemble each other? There is a great abundance of examples to prove the contrary.

Now let us discuss actual chronological results of Y. N. Yefremov, who has attempted to perform a dating of the Almagest star catalogue by proper star motions. He came up with a result that he believes to prove Scaligerian chronology ([p21] and [p22]). Unfortunately, Y. N. Yefremov's works on the dating of the Almagest catalogue contain an error of roughly 1000 years in the precision estimate of the dates that he comes up with. This is what invalidates Yefremov's dating of the Almagest catalogue completely. We have studied Yefremov's errors in the dating of the Almagest star catalogue and written about them at sufficient length – see [p6], [p7] and [p8]. We shall refrain from yet another reiteration.

However, in the article published in [p19] and considered presently Y. N. Yefremov claims that his new work co-authored by A. K. Dambis ([p23]) contains an error-free (as he would like to believe) proof of the Scaligerian dating of the Almagest star catalogue, and, consequently, Scaligerian chronology in general. Moreover, Y. N. Yefremov claims that his old method of dating the Almagest, which we have discussed attentively in a number of publications, "has been rendered meaningless by the results of research related in the article" ([p23]; see [p19], page 145). In other words, according to Y. N. Yefremov, all his former errors in the dating of the Almagest have been corrected, and the result remains the same – one that proves Scaligerian chronology. Y. N. Yefremov reports no details concerning his new method of dating in [p19], referring the reader to the English publication in the Journal for History of Astronomy ([p23]).

Let us therefore consider the article in question (written by Y. N. Yefremov together with A. K. Dambis ([p23]}}. According to the authors, the article in question describes two radically new methods of dating Ptolemy's star catalogue. It goes without saying that both methods "prove the correctness of Scaligerian chronology", according to the authors of [p23]. However, our analysis of the publication in question ([p23]) demonstrates that, alack and alas, Y. N. Yefremov and his co-author A. K. Dambis stubbornly repeat the very same old error of Y. N. Yefremov – incorrect estimation of the precision of the approximate dates yielded by their research.

The first of the two novel Almagest catalogue dating methods as offered by Y. N. Yefremov and A. K. Dambis is described in the "Results of Mutual Distances Method" section of [p23]. The method itself was simply taken from our book ([p8]), as Y. N. Yefremov and A. K. Dambis tell the reader explicitly ([p23], page 121). They are of the opinion that we haven't noticed just how "good" the results of this method's application can be "in reality" ([p23], oage 121). However, in our book about the dating of the Almagest star catalogue ([p6], [p7] and [p8]) we explain it with sufficient clarity why the method in question, as well as several other simple approaches to the dating of the Almagest catalogue, cannot yield any non-trivial result. The main reason is the low precision of the dates that we arrive at when we use these methods; as a result, the scatter range for the actual dates turns out too great. Consequently, any dating of the Almagest catalogue that employs methods this simple turns out non-informative, or trivial. As for the method that Y. N. Yefremov and A. K. Dambis borrowed from our book, we refer the readers to Section 3 of Chapter 3 of [p6], or, alternatively, to section 3.3 of our book on the dating of the Almagest (edition [p7]). See also Section 7.4, "Dating the Almagest Catalogue by an Expanded Informative Kernel" in the last edition of said work ([p7]).

We are once again confronted by a strange reluctance of Y. N. Yefremov to treat the problem of precision estimation in the dating of the Almagest catalogue with due respect. Y. N. Yefremov's precision estimates of the resulting catalogue's datings are either altogether absent, as in the case we have just considered, or just erroneous. The above example of Yefremov and Dambis borrowing a dating method from our book – a method we rejected due to the insufficient precision of its results, no less, demonstrates Y. N. Yefremov's attitude towards the issue of precision estimates in general. Nevertheless, precision estimates are an issue of paramount importance insofar as this problem is concerned. See [p6] and [p7] for more details.

Let us consider the next section of the article ([p23]). It is called "The Case of *o* Eri. The authors tell us directly: "The fastest of the Almagest stars, *o* Eri is important for catalogue dating by means of proper motions". This is indeed the case. However, in order to use *o* Eri for the dating of the Almagest, one needs to be certain that the star in question was actually included in the Almagest catalogue at the very least. In order to prove this, Y. N. Yefremov and A. K. Dambis refer to the works of several astronomers who sought the identification of Almagest star 779 (in Bailey's numeration), called "the star in the middle" by Ptolemy in the Almagest. Indeed, most researchers identify this rather unremarkable Almagest star as *o* Eri, a modern star that is just as unremarkable. However, it has to be emphasised that the only basis for this identification is that the star in question corresponded to the coordinates of star #779 as given in the Almagest best in the epoch of the II century A.D., which is where Scaligerian chronology places Ptolemy. No other proof of the above identification was given except for coordinate correspondence – this star is neither characterised by luminosity, nor by anything in the way of a proper name or a detailed description in the Almagest.

However, let us recollect the fact that the star *o* Eri possesses a very high proper motion rate. Its visible position on the celestial sphere changes notably over the course of time. So if *o* Eri was indeed the best identification candidate for the Almagest star #779 in the beginning of the Anno Domini epoch, this is by no means the case for other historical epoch. The fact that the astronomers chose *o* Eri as their best identification candidate for the Almagest star #779 is a trivial consequence of the fact that the astronomers had already referred to information concerning proper star motions as well as the inevitable Scaligerian dating of the Almagest. In other words, the identification in question, which is of great importance for Y. N. Yefremov, is merely a consequence of the Scaligerian dating of the Almagest. To use it for the dating of the Almagest would be tantamount to solving the reverse problem of restoring the Scaligerian dating of the Almagest used by the astronomers of the XVIII-XX century for the identification of Ptolemy's stars. However, the dating in question is known to us perfectly well; it is a Scaligerian dating. It is obvious enough that Y. N. Yefremov's approach cannot lead him to any other dating of the Almagest but the Scaligerian. This is the vicious circle in Yefremov's conclusions that keeps on mistaking the effect for the cause.

We have explained it to Y. N. Yefremov several

times that the use of *o* Eri for the dating of the Almagest catalogue is useless, since it leads one to a vicious circle. Our book ([p6], [p7] and [p8]) discusses this at great length, citing the respective drawn copies of real stars and their Ptolemaic equivalents in the constellation of Eridanus. Nevertheless, Y. N. Yefremov keeps on dating the Almagest by *o* Eri, never quite free from the vicious circle in question. These explanations become rather taxing at the end of the day.

The next section of [p23] is entitled "The Bulk Method"; it concludes the actual content part of [p23]. The remaining sections of the article deal with conclusions and acknowledgements.

According to the authors of [p23], in this section they offer a method of dating the Almagest catalogue by proper motions that is substantially different from the old method of Y. N. Yefremov ([p21] and [p22]). According to Y. N. Yefremov and A. K. Dambis ([p23]), the crucial difference between the old and the new method is that this time all the fast stars of the Almagest at once were used for the dating of the Ptolemaic catalogue, whereas previously each of the fast stars was used for the dating calculations separately ([p23], page 125).

However, one instantly becomes somewhat astonished by the fact that the use of the new evolved dating method did not raise the precision of Y. N. Yefremov's end dating – on the contrary, the precision was impaired. In his previous work ([p21]) Y. N. Yefremov dates the Almagest to 13 A.D. with the precision margin of ± 100 years. In [p23], using a more evolved dating method, Y. N. Yefremov only managed to attain the precision of ± 122 years. The result of Yefremov's new dating of the Almagest is as follows: 90 B.C. ± 122 years ([p23], page 128). Thus, the method has evolved, yet the precision of results has deteriorated. How is one supposed to interpret this?

The answer is that similarly to the errata made in [p21], in [p23] Y. N. Yefremov gives a false estimate of the resulting datings' precision.

We already considered the figmental nature of the precision margin claimed by Y. N. Yefremov for his datings of the Almagest catalogue in our analysis of Y. N. Yefremov's prior works. See also an in-depth discussion of this issue in [p6] (pages 99-102) and [p7] (pages 200-212). A simple calculation demonstrates that the real precision margin of Y. N. Yefremov's method roughly equals a thousand years and not 100-120 years, as he believes for some reason.

Incidentally, in his very first work dedicated to the dating of the Almagest ([p21]) Y. N. Yefremov describes how he arrived at his precision estimate in sufficient detail. This gave us the opportunity of discovering the error in his postulations, which was duly pointed out to him ([p6], pages 99-102 and [p7], pages 200-212). In the last work of Y. N. Yefremov ([p23]) concerned with the dating of the Almagest by proper star motion rates he makes just as far-fetched claims of his precision estimates without any validation whatsoever. [p23] doesn't contain any formulae or algorithms that would lead Y. N. Yefremov to his estimates. He appears to have written no other works with any more details, either. At the very least, neither [p19], nor [p23] contain any references to any such works. Therefore, it is difficult to point out the actual errors made in the precision estimation by Y. N. Yefremov as per [p23]. However, there is no need to do any such thing. The fact that the dating precision estimates as given in [p23] contain an error is implied by our analysis of the Almagest catalogue precision characteristics as related in [p6] and [p7]. These characteristics imply that the precision of dating the Almagest catalogue by proper star motion rates with the method of Y. N. Yefremov cannot be any higher than ± 400-500 years if arc discrepancies are used, or, at the very least, ± 300 years (with the use of latitudinal discrepancies – see [p7], page 206, and [p7] in general).

Furthermore, it is possible that in [p23] Y. N. Yefremov conducted a deliberate preliminary selection of fast star neighbourhoods, hence the "desired" result. At least, the text of the article ([p23]) is rather vague about the rules adhered to in the choice of a given fast star's neighbourhoods for the final dating. Since the method of Y. N. Yefremov demonstrates no stability in face of neighbourhood star choice, a careful selection of neighbourhood stars will yield the very date of the Almagest catalogue that was intended a priori. See more details in our analysis of Y. N. Yefremov's method ([p6], pages 99-102; also [p7], pages 200-212).

In general, the new method of dating the Almagest by proper star motions as suggested in [p23] is little different from the initial method as related in [p21] and [p22]. The primary difference is that previously

Y. N. Yefremov would calculate the datings by each of the fast stars separately (after a certain choice of its neighbouring stars). It has to be explained that in Y. N. Yefremov's method the position of a fast star is defined in relation to its neighbourhood. We have discovered that a change in the choice of neighbouring stars can greatly affect the resulting dating yielded by this method ([p6], pages 99-102; also [p7], pages 200-212). Now, in [p23], Y. N. Yefremov suggests to calculate a single date with the aid of all the fast stars at once. He uses a certain neighbourhood selection rule that remains unclear from the text of [p23]. Y. N. Yefremov and A. K. Dambis define the desired single date as follows ([p23], page 125).

Yefremov and Dambis consider the ecliptic coordinates on the celestial sphere for the epoch of the beginning of the new era. One of the coordinates is fixed as a result – either the latitude or the longitude. After that, each of the datings is presented as a point on a plane. The proper motion rate component of a given fast star along the coordinate in question is represented on the horizontal axis (with a certain compensation of neighbourhood star velocities, which is of no substantial meaning here). Points on the vertical axis represent the discrepancy by a given coordinate for the averaged distance between the fast star in question and the stars of its neighbourhood. Chosen discrepancy represents the difference with the averaged distance calculated by the Almagest, and a similar distance on the calculated celestial sphere for the beginning of the Anno Domini era. The result is a point on a certain plane. After that, the dating of the fast star in question and its neighbourhood by the method of Y. N. Yefremov is represented by a declination of the straight line that crosses the beginning of the coordinate system and the point in question.

This procedure is performed by both ecliptic coordinates (latitude and longitude) for all the fast stars and their varying neighbourhoods. This results in a field of dots on a plane. Obviously enough, if the Almagest catalogue contained ideally precise star coordinates, all such dots would pertain to a single line, whose declination would represent the dating of the catalogue. However, given the erroneous coordinates of the Almagest stars, this is not the case. Y. N. Yefremov and A. K. Dambis got the idea of using the linear regression method in order to estimate the dating of

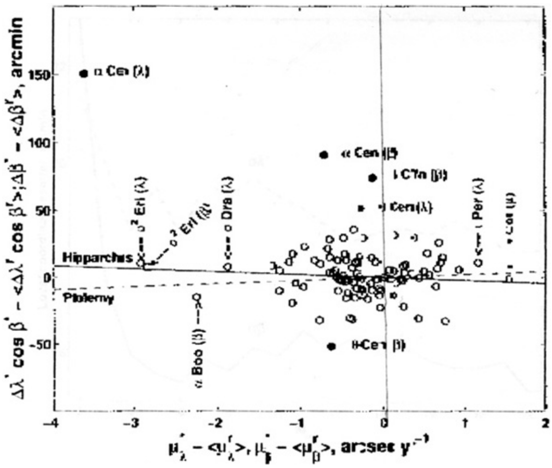

Fig. P8.1. An illustration from the work of Y. N. Yefremov and A. A. Dambis that depicts a field of dots that represent various Almagest datings made by separate configurations. Yefremov and Dambis drew a regression curve across the field of dots, whose declination is supposed to stand for the Almagest dating according to their method. There are two such curves in the illustration – one of them corresponds to the Scaligerian epoch of Ptolemy, and the other – to the Scaligerian epoch of Hipparchus. According to Y. N. Yefremov and A. A. Dambis, this star field defines the regressive curve with such precision that it renders the Ptolemaic version obsolete, whereas the Hipparchian version remains valid – in spite of the great proximity of both versions insofar as their drawing is concerned. This opinion of Y. N. Yefremov and A. A. Dambis is more than dubious. A field of dots such as we see on their drawing obviously does not permit so much as to define the declination of the regressive curve with precision sufficient for distinguishing between the beginning of the New Era and the XVI century, for example.

the catalogue by the declination of the regressive line that crosses the resulting field of dots.

The idea makes perfect sense per se. However, the field of dots that Y. N. Yefremov and A. K. Dambis came up with for the Almagest ([p23], page 124, ill. 5) does not permit an estimation of the regressive line's declination with the precision margin they declare – little wonder, considering the principal lack of precision in their method.

The field of dots that we see in ill. 5 of [p23] more or less chaotically fills the area that resembles an ellipsis whose center coincides with the beginning of the coordinates. See fig. P8.1, which reproduces ill. 5 from

the work of Yefremov and Dambis. We have added the missing vertical axis that crosses zero. The ellipsis formed by the field of stars in fig. P8.1 is somewhat stretched horizontally (the relation between the half-axes roughly equalling 2:1). Y. N. Yefremov and A. K. Dambis claim that the declination level of the regressive line defined by such "ellipsoidal" field of dots is close to zero. Moreover, they are de facto making the claim that this level can be defined with the mind-boggling precision of several degrees ([p23], page 125, ill. 5). This is more than doubtful. Obviously, Y. N. Yefremov has once again made an error in the precision estimate of the resulting dating.

Let us make a conclusion. The new work of Y. N. Yefremov concerned with the dating of the Almagest that he refers to in [p19] is de facto but another version of his old Almagest dating method. It repeats the same error that Y. N. Yefremov made previously – a wrong precision estimate of the dating he comes up with. Moreover, in this work Y. N. Yefremov once again uses the star *o* Eri for dating purposes, whose very presence in the Almagest catalogue can only be justified by the assumption that the catalogue was compiled at the very beginning of the A.D. era, which is its Scaligerian dating. It is clear that the use of such a star for the purpose of dating the catalogue leads one to a vicious circle.

Our analysis of the article entitled "Dating Ptolemy's Almagest by Planetary Configurations" *([p19], pages 111-123)* by A. A. Venkstern and A. I. Zakharov and the article of Y. D. Krasilnikov, "On the Planetary Coverings of Stars in Ptolemy's Almagest" *([p19], pages 160-165).*

The first part of the article by A. A. Venkstern and A. I. Zakharov deals with the attempt to date the Almagest by the 23 planetary observations that Ptolemy claims as his own ([p19], page 111). A. I. Zakharov is an astronomer and a staff member of the Sternberg State Institute of Astronomy. A. A. Venkstern is a mathematician; A. T. Fomenko was her Academic Advisor at the MSU Department of Mathematics and Mechanics. The article contains a number of calculations that we did not verify ourselves – however, we have no reason to doubt their veracity. Let us cite the authors' result – it doesn't contradict our research of the Almagest in the least.

A. A. Venkstern and A. I. Zakharov make the following corollary: "We believe that one of the following two postulations is true: *a)* the planetary observations that served Ptolemy as a basis for his theory were indeed conducted in the II century A.D.; *b)* these observations have been calculated in accordance with a certain theory for the date in question" ([p19], page 111).

A. A. Venkstern and A. I. Zakharov tell us the following in re option b, or the falsification of the Almagest: In order to verify the possibility that the data were supplanted by mediaeval hoaxers (before Kepler's theory) we decided to check the growth rate of the discrepancy in Ptolemaic theory. This can also be formulated as follows: how far away was the hoaxer's (Ptolemy's) epoch from the traditional Almagest dating in reality to give him the opportunity of fabricating and introducing false observations using the theory related in the Almagest? … Our conclusion is as follows: said observations could not have been falsified with the aid of a theory of the Ptolemaic sort – the "life expectancy" of such theories does not exceed 200 or 300 years" ([p19], page 114).

All of this happens to be in perfect correspondence with our calculations and our reconstruction (see "The Astronomical Analysis of Chronology" ([p7]) for more details). We are of the opinion that the Almagest (in the form that we know today – see [p7]) is a XVII century edition. In other words, it is a re-edition of some famed old astronomical work that was made in the epoch of Kepler. All the activities associated with the editing of the Almagest, which date from the XVII century, can be regarded as falsification. Its aim was to make the Almagest resemble a work of the alleged II century A.D. The epoch in question was taken from the Scaligerian chronological tables. The Scaligerite hoaxers have rendered all the astronomical data in the Almagest that they could calculate retroactively to the II century A.D. – Ptolemy's planetary theory, for instance. This is what A. A. Venkstern and A. I. Zakharov have now discovered in their work as published in [p19]. One must give them credit for being explicit about what exactly they have proved.

The astronomical data that could not be calculated reliably in the XVII century (such as solar

eclipses) were simply excluded from the Almagest. As a result, the modern version of the Almagest rather strangely fails to mention so much as a single solar eclipse. We are lucky that the XVII century hoaxers haven't removed the old Ptolemaic star catalogue from the Almagest altogether – most likely, they simply didn't suspect that such catalogues might give on the opportunity of dating the Almagest with the aid of such a subtle effect as proper star motions ([p7]). Rougher effects (such as longitudinal precession) were naturally taken into account.

As for longitudinal precession – calculating it in reverse for the I century A.D. was an easy enough task already in the XV-XVI century, let alone the XVII. We have to remark that another critic of ours, the astronomer Y. N. Yefremov, keeps making claims in numerous publications about the possibility of dating the Almagest by longitudinal precession, or de fact restoring the data introduced by the XVII century Scaligerite editors, thus "effectively confirming" the veracity of Scaligerian chronology. These rather amusing ruminations of Y. N. Yefremov can also be found in [p19], page 143.

And so, going back to the work of A. A. Venkstern and A. I. Zakharov, we can conclude with the statement that the result they came up with neither contradicts New Chronology, nor our reconstruction of history. It does, however, contradict the Scaligerian version of chronology and history, and very much so, although for some reason this circumstance isn't mentioned anywhere by Venkstern or Zakharov.

The matter is as follows. In the section of their article entitled "The Possibility of Falsifying the Almagest Planetary Observations with the Aid of Other Theories" ([p19], pages 113-114), A. A. Venkstern and A. I. Zakharov study the "life expectancy" of the planetary theory as related in the Almagest. It has to be said that the characteristics of planetary orbits change slowly with the course of time. Therefore, a given planetary theory that could function satisfactorily in the epoch of its creation could become utterly useless in several hundred years, and would naturally have to be replaced by a new theory, or at least improved by means of parameter correction. So what was the life expectancy of the Ptolemaic theory?

A. A. Venkstern and A. I. Zakharov provide the following answer: 300 years maximum. According to their calculations, "the error inherent in the Ptolemaic theory accumulates very quickly; therefore, the theory works very poorly with such parameters beyond the temporal vicinity of 300 years … The 'life expectancy' of such a theory equals a mere 200-300 years" ([p19], page 114).

Let us now assume the correctness of the Scaligerian historical and chronological system, and also that the Almagest as it is known to us today was indeed compiled by Ptolemy around the beginning of the new era – in the I-II century B.C. or the I-II century A.D. The implication is that the planetary theory as related in the Almagest ceased to be functional in the VI-VII century. If we add 300 years (the maximal life expectancy of this theory calculated by A. A. Venkstern and A. I. Zakharov) to the Scaligerian date of the Almagest's completion (circa 150 A.D. as per [p24], page 430), we shall come up with 450 A.D. (500 or 600 A.D. if we stretch the period to the maximum) – not any later. The Ptolemaic planetary theory should have become obsolete or modified after that.

What do we learn from Scaligerian history textbooks? The Scaligerian version is of the opinion that the Almagest remained the primary source of astronomical knowledge in general and the planetary theory in particular up until the Copernican epoch, or the XVI century A.D. ([p24], pages 445-458; also [p25], pages 2-3). See also our review of the Almagest's history in its Scaligerian version ([p7], pages 19-21).

It turns out that astronomers and mathematicians had kept a functional planetary theory for 200 or 300 years, and then used an utterly imprecise planetary theory for over a millennium – one that lost the last vestiges of precision by the V-VI century A.D. and became completely unsatisfactory, deciding to abandon it as late as the XVI century A.D. Up until that very moment they had no qualms about using it, translating it into other languages, studying it, admiring it etc. Nobody thought of so much as correcting the theory's planetary orbit parameters; had this been done, the calculations of A. A. Venkstern and A. I. Zakharov would yield the date of the last correction and not the I century A.D.

The picture we come up with is unrealistic. The only explanation of the results obtained by A. A. Venkstern and A. I. Zakharov that we deem reasonable is that the Almagest planetary theory as we know it

today was introduced into said work in the XVII century, the epoch of Kepler, with the goal of falsifying its dating – it was a matter of paramount importance for the nascent Scaligerian version of history and chronology (see [p7] for more details). Quite naturally, the hoaxers made the planetary orbit parameters fit the desired date – the beginning of the new era. This is precisely what A. A. Venkstern and A. I. Zakharov have discovered in their work.

In the next and final section of their article published in [p19] A. A. Venkstern and A. I. Zakharov criticise the astronomical solution of the four planetary coverings of stars as described in the Almagest that we came up with as a result of our research. Let us remind the reader that our solution was as follows: morning of 14 February 959 A.D. for Mars, morning of 18 October 960 A.D. for Venus, dawn of 25 July 994 A.D. for Jupiter and the evening of 16 August 1009 A.D. for Saturn. It is in excellent correspondence with the dating of the Almagest star catalogue by proper star motions. The possible interval for the Almagest star catalogue dating by proper motions is 600 A.D. – 1300 A.D. ([p7], page 392). Our solution falls right over the centre of the interval.

Apart from that, we have discovered that our solution for the planetary star coverings ideally satisfies to the time of day conditions of said coverings as per Ptolemy's own words ([p7], pages 454-467). For example, in case of Mars Ptolemy reports the covering to have been visible in the morning. Indeed, in our solution Mars could only be visible after midnight and until the morning. In case of Jupiter Ptolemy tells us that the covering could be observed at dawn; in our solution, Jupiter rose exactly an hour before sunrise, remaining in the dawn region of the sky all the time. As for the "traditional" (or Scaligerian) solution, it claims that Jupiter was visible all night, remaining right next to the star, which makes Ptolemy's words about the covering observed at dawn extraneous and rather odd, as a matter of fact. In other words, the traditional solution is rather far-fetched – here as well as elsewhere. Further on, Ptolemy reports that Saturn approached the star in the evening. Quite so – in our solution Saturn set one hour after the Sun and was therefore only visible in the evening, at dusk. This is not the case with the Scaligerian solution, which claims that Saturn was visible all night long, once again rendering Ptolemy's report of evening observation inappropriate. In case of Venus, the concurrence between our solution and the Ptolemaic description is also excellent ([p7], pages 454-467).

On the other hand, we did not need our coverings solution to be the only one possible, given that there are no ideal solutions for the problem in question, seeing as how in case of Mars, for example, the term "covering" stands for the proximity of 15 arc minutes between Mars and the star in question. Such proximity is not actually a covering, strictly speaking. Moreover, Mars did not cover the star under consideration at any point on the historical interval. Therefore, the issue of a unique solution becomes rather vague. The ideal solution remains nonexistent; as for near-ideal ones, they multiply as the Ptolemaic stipulations are made less rigid. We pointed out this fact in [p7]; it is also confirmed in the article of A. A. Venkstern and A. I. Zakharov.

However, the comparison of our planetary coverings solution to the Scaligerian solution, which A. A. Venkstern and A. I. Zakharov perform in their article, compiling their results into a brief table ([p19], page 117), is perfectly unjustified and even erroneous. The table claims that our solution "doesn't satisfactorily correspond to the circumstances of the coverings", whereas the Scaligerian solution "describes said circumstances in a more or less satisfactory way" ([p19], page 117). This is incorrect, and we have just cited a number of examples to prove the opposite. This issue can be studied in greater depth in our previous books and also in the present book, see Chapter 10.

Also, the claim made by A. A. Venkstern and A. I. Zakharov about their discovery of five further series of datings for the coverings that conform to Ptolemaic descriptions just as well as the one discovered by the authors of the present work strikes us as rather doubtful. Of course, considering the lack of an ideal solution, one might well debate whether or not one of the possible solutions is "better" or "worse" than another. Nevertheless, we feel obliged to point out that none of the solutions cited by A. A. Venkstern and A. I. Zakharov in their table on page 119 of [p19] correspond to the visibility conditions as mentioned above ("in the morning", "in the evening" and "at dawn", as per Ptolemy's indication). This is already obvious if

we consider the "solar elongation" column of said table ([p19], page 119).

As for our solution, which was also included in the table of A. A. Venkstern and A. I. Zakharov, one cannot help noticing the strange misprint in the Jupiter line. In the second column it is indicated that on the day when Jupiter covered the star the end of the night (the dawn) came at 4:36 local time, whereas the fifth column of the same line states that the Sun rose at 4:58 local time. However, the Sun rises about an hour after dawn, or the end of the night. This fact is known to A. A. Venkstern and A. I. Zakharov perfectly well, and they say so clearly on page 117 ([p19]). This is also obvious from all the other lines of their table ([p19], page 119). Why, then, would the Sun rise a mere 20 minutes after dawn that day?

This might be a random misprint. However, A. A. Venkstern and A. I. Zakharov comment the line in question as follows: "The time of Jupiter rising is indicated up to 6 degrees over the horizon. The dim star delta Cnc cannot be seen due to its proximity to the Sun" ([p19], page 118). In other words, A. A. Venkstern and A. I. Zakharov point out what they believe to be a defect of our solution, according to which the covering as described by Ptolemy "could not have been observed anywhere in the world" ([p19], page 118). They make a similar claim concerning Saturn on the very same page. Both claims of A. A. Venkstern and A. I. Zakharov do not correspond to reality. However, the misprint in their table as mentioned above leaves one with the impression that the situation is exactly as they describe it, since it is presumed that the covering of the star by Jupiter could only be seen 20 minutes before sunrise (when the star could not be made out on the brightened sky by the observer, naturally enough – no covering could take place under such circumstances). In reality, calculations (such as one can make with the aid of the simple computer program "Turbo-Sky", quite convenient for approximated calculations, for example) demonstrate that in our solution the maximal propinquity between Jupiter, Saturn and the respective stars took place one hour before sunrise in case of Jupiter and one hour after sunset in case of Saturn. Therefore, the coverings could be observed perfectly well, albeit for a short time. This is precisely why Ptolemy refers to observations carried out "at dawn" and "in the evening".

However, the possibility of real star covering observation in our solution is an issue that has no principal significance for either the New Chronology in general or the dating of the Almagest. The matter is as follows: seeing as how the solution in question isn't strict (no ideal coverings), there is a theoretical possibility that the coverings were calculated and not actually observed – in other words, we are not dealing with de facto observation reports, but rather the results of mediaeval calculations, which, obviously enough, lacked sufficient precision.

Let us now consider the article of Y. D. Krasilnikov under the following title: "On the Planetary Coverings of the Stars in Ptolemy's Almagest" ([p19], pages 160-165). In this article Y. D. Krasilnikov considers the Scaligerian solution of the problem of dating the coverings. In particular, he is forced to acknowledge the fact that the covering of a star by Venus that Ptolemy claims to be "exact" is a mere case of 12 arc minute propinquity in the Scaligerian solution ([p19], page 161). This hardly classifies as an "exact covering", which makes the solution defended by Y. D. Krasilnikov obviously far-fetched. There are quite a few other such instances. For instance, Ptolemy emphasises the fact that the star's covering by Jupiter was observable at dawn, whereas in the solution of 241 B.C. (defended by Y. D. Krasilnikov) Jupiter and the star it approached was visible almost all night long – for circa five hours ([p19], page 163). This also makes the Scaligerian solution rather far-fetched. Ptolemy's indication concerning the evening time of the observed proximity between Saturn and said star becomes suspended in midair, in a way, insofar as the solution favoured by Y. D. Krasilnikov is concerned. In this solution Saturn was visible all night long. The perplexed comment that Y. D. Krasilnikov made in this respect, with rather irrelevant complaints about the deficiencies of the software that he had used for the calculations of the covering results, can be read on page 163 of [p19].

Incidentally, Y. D. Krasilnikov, likewise A. A. Venkstern and A. I. Zakharov, is for some reason convinced that it is important for the New Chronology and for our dating of the Almagest that the covering solution that we suggest be unique. This is not so – the very existence of a coverings solution that is in good correspondence with our dating of the Almagest cata-

logue suffices, even if said solution is not the only one possible. See [p7] for more details.

At the end of his article Y. D. Krasilnikov makes a comparison of our solution and the Scaligerian solution that he favours, trying to prove ours to be "much worse". Y. D. Krasilnikov makes his primary emphasis on the fact that we did not account for the solar longitude as indicated in the Almagest by Ptolemy in his discussion of planetary star coverings. Our reply is as follow. Firstly, solar longitude isn't part of the observations used by Ptolemy. In the Almagest, longitudes are calculated for each covering. Secondly, it is easy enough to realise that the solar longitude is the very same thing as a date, albeit transcribed in a different manner.

Since the only version of the Almagest that we have at our disposal today is the one that was fabricated in the XVII century, it would make no sense to expect that Scaligerian editors of the Almagest would fail to render such simple things as solar longitudes to a desired Scaligerian date. There is no doubt about the fact that all such data were meticulously brought into correspondence with the Scaligerian version. This is exactly what Y. D. Krasilnikov discovers today, studying solar longitudes as indicated in the Almagest and believing to be "reconstructing" the true dating of the Almagest. In reality, he merely reconstructs the opinion of the XVII century hoaxer editors of the date in question. This opinion is known to us perfectly well, at any rate – every textbook contains Scaligerian datings. It is most peculiar that Y. D. Krasilnikov should fail to comprehend this – apparently, he has never bothered to read our book ([p6] and [p7]), which contains a detailed explanation of all the phenomena mentioned above.

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(In 1998 we convinced Kraft, a Muscovite publishing house, to publish a reprint edition of this work. All seven volumes were published anew.)

WIKIPEDIA Damage Control on New Chronology (Fomenko) page

This page is set up and run by historians. Thanks to the regular interventions of NC supporters it has changed from wildly to mildly anti-Fomenko bias. Don't be astonished to see NC theory labeled as: paranormal, pseudohistory, pseudoscience, etc… In most cases initial critical statements were added without reading the books of Dr Fomenko and team. Useful as NC overview. We publish excerpts of this page *as is* on May 29, 2007, 13.00 GMT.

The **New Chronology** of Anatoly Timofeevich Fomenko is an attempt to rewrite world chronology, based on his conclusion that world chronology as we know it today is fundamentally flawed. The ideas of the New Chronology are a direct continuation of earlier ideas of Nikolai Morozov, and may have had their origin in the theories of the French scholar Jean Hardouin. The chronology is commonly associated with the name of Fomenko, although it is, in fact, a collaboration of Fomenko with several other Russian mathematicians, including Gleb Vladimirovich Nosovsky.

The "New Chronology" is radically shorter than the conventional chronology, because all of ancient Greek/Roman/Egyptian history is "folded" onto the Middle Ages and Antiquity, and the Dark Ages are eliminated. According to Fomenko, the history of humankind goes only as far back as A.D. 800, we have almost no information about events between A.D. 800-1000, and most historical events we know took place in A.D. 1000-1500.

These views are entirely rejected by mainstream scholarship. While some mainstream researchers have offered revised chronologies of Classical and Biblical history which do shorten the timeline of ancient history by eliminating various "dark ages," none of these revisionist chronologies are as radical as Fomenko's: the events which are traditionally assumed to have happened in the centuries before A.D. 1 are still thought to have happened thousands of years ago, not hundreds of years ago as in Fomenko's timeline.

History of New Chronology

The idea of chronologies different from the conventional chronology can be traced back to at least the early 17th century. Jean Hardouin then suggested that many ancient historical documents were much younger than commonly believed to be. In 1685 he published a version of Pliny the Elder's *Natural History* in which he claimed that most Greek and Roman texts had been forged by Benedictine monks. When later questioned on these results, Hardouin stated that he would reveal the monks' reasons in a letter to be revealed only after his death. The executors of his estate were unable to find such a document among his posthumous papers.[1] In the 18th century, Sir Isaac Newton, examining the current chronology of Ancient Greece, Ancient Egypt and the Ancient Near East, expressed discontent with prevailing theories and proposed one of his own, which, basing its study on Apollonius of Rhodes's *Argonautica*, changed the traditional dating of the Argonautic Expedition, the Trojan War, and the Founding of Rome.[2][3]

In 1887, Edwin Johnson expressed that early Christian history was largely invented or corrupted in the 2nd and 3rd centuries.[4] In 1909 Otto Rank made note of duplications in literary history of a variety of cultures:

…almost all important civilized peoples have early woven myths around and glorified in poetry their heroes, mythical kings and princes, founders of religions, of dynasties, empires and cities – in short, their na-

tional heroes. Especially the history of their birth and of their early years is furnished with phantastic [sic] traits; the amazing similarity, nay literal identity, of those tales, even if they refer to different, completely independent peoples, sometimes geographically far removed from one another, is well known and has struck many an investigator.[5]

In 1939 Sigmund Freud attempted to reconstruct biblical history in accordance with his contributions to social psychology.[6]

Nikolai Morozov was the first to claim the existence of correlations between the dynasties of Old-Testament kings and Roman emperors and to suggest that the entire chronology prior to the 1st century B.C. is wrong.[citation needed]

Fomenko became interested in Morozov's problematic theories in 1973. In 1980, together with a few colleagues from the mathematics department of Moscow State University, he published several articles on "new mathematical methods in history" in peer-reviewed journals. The articles stirred a lot of controversy, but ultimately Fomenko failed to win any respected historians to his side. By early 1990s, Fomenko shifted his focus from trying to convince the scientific community via peer-reviewed publications to publishing books. His books range from popular to rather involved, yet accessible to educated readers.

By 2005 his theory had grown to cover all of the Old World, from England and Ireland to China.

Fomenko claims:

1) That different accounts of the same historical events are often 'assigned' different dates and locations by historians and translators, creating multiple "phantom copies" of these events; these "phantom copies" are often misdated by centuries or even millennia;

2) That all these events, actual and fictional alike, end up incorporated into conventional chronology;

3) That, as a consequence, the chronology universally taken for granted is simply wrong, and it mainly repeats events from 900 A.D. onwards;

4) That this chronology was essentially invented in the 16th and 17th centuries;

5) That archaeological dating, dendrochronological dating, paleographical dating, carbon dating, and other methods of dating of ancient sources and artifacts known today are erroneous, non-exact or dependent on traditional chronology;

6) That there is not a single document in existence that can be reliably dated earlier than the 11th century;

7) That Ancient Rome, Greece and Egypt were crafted during the Renaissance by humanists and clergy;

8) That the Old Testament is probably a rendition of events that occurred in the Middle Ages, and that the New Testament is actually older than the Old Testament;

9) That currently accepted chronology has many inconsistences, but these are generally overlooked and ignored, giving the perception that there are no problems;

10) That Egyptian horoscopes give dates of 1000 A.D. and up to as late as 1700 A.D.;

11) That the Book of Revelation we know of contains a horoscope that is dated to 25 September – 10 October 1486 A.D. compiled by cabbalist Johannes Reuchlin.

12) That the horoscopes contained in Shumerian/Babilonian tablets have solution every 30-50 yrs on the time axis therefore useless for dating.

13) That the Chinese tables of eclipses are useless for dating as they contain too many eclipses that did not take place.

Detailed description

Fomenko's theory claims that the traditional chronology consists of four overlapping copies of the "true" chronology, shifted back in time by significant intervals (from 300 to 2000 years), with some further revisions. All events and characters conventionally dated earlier than 11th century are either fictional or, more commonly, represent "phantom reflections" of actual Middle Ages events and characters, brought about by intentional or accidental misdatings of historical documents. Before the invention of printing, accounts of the same events by different eyewitnesses were sometimes retold several times before being written down, then often went through multiple rounds of translating, copyediting, etc.; names were translated, mispronounced and misspelled to the point where they bore little resemblance to originals. According to Fomenko, this led early chronologists to believe or choose to believe that those accounts described different events and even different countries and time periods. Fomenko justifies this approach by the fact that, in many cases, the original documents are simply not available: most of the history of ancient world is known to us from manuscripts that are conventionally dated centuries, if not millennia, after the events they describe.

For example, Fomenko claims that the historical Jesus is a reflection of the same person as the Old-Testament prophet Elisha (850-800 B.C.?), Pope Gregory VII (1020?-1085), Saint Basil of Caesarea (330-379), and even Li Yuanhao (also known as Emperor Jingzong or "Son of Heaven" – emperor of Western Xia, who reigned in 1032-1048). Further, John the Baptist baptized Jesus, someone named Maxim baptized St. Basil, the prophet Elijah was the predecessor of Elisha, and John Crescentius was in some way a predecessor of Pope Gregory VII; consequently, according to Fomenko, all of them are also reflections of the same person. Fomenko explains the seemingly vast differences in the biographies of these figures as resulting from difference in languages, points of view and timeframe of the authors of said accounts and biographies.

Merging together the biographies of the aforementioned people requires also to merge *cities*, because conventional history places them throughout the entire ancient world, from Jerusalem to Rome. Fomenko identifies all their cities: "New Rome" = Constantinople = Jerusalem = Troy. The Biblical Temple of Solomon was not completely destroyed, says Fomenko – it is still known to us as the Hagia Sophia in Constantinople. The historical Jesus may have been born in 1152 and was crucified around 1185 A.D. on a hill overlooking the Bosphorus*(Г.В.Носовский, А.Т. Фоменко Датировка Рождества Христова серединой XII века)*. The city that we now know as Jerusalem was known prior to the 17th century as a nondescript Palestinian village of Al-Quds.

On the other hand, according to Fomenko the word "Rome" can signify any one of several different cities and kingdoms. The "First Rome" or "Ancient Rome" or "Mizraim" is an ancient Egyptian kingdom in the delta of the Nile with its capital in Alexandria. The second and most famous "New Rome" is Constantinople. The Italian Rome is at least third in the list of cities known as "Rome"; it was allegedly founded around 1380 A.D. by Aeneas. Similarly, the word "Jerusalem" is a placeholder rather than a physical location and can refer to different cities at different times.

Parallelism between John the Baptist, Jesus, and Old-Testament prophets implies that the New Testament was written before the Old Testament. Fomenko claims that the Bible was being written until the Council of Trent (1545-1563), when the list of canonical books was established, and all apocryphal books were ordered destroyed.

As another unrelated example, according to Fomenko, Plato, Plotinus and Gemistus Pletho are one and the same person – according to him, some texts by or about Pletho were misdated and today believed to be texts by or about Plotinus or Plato.

Fomenko's methods

Statistical correlation of texts

One of Fomenko's simplest methods is statistical correlation of texts. His basic assumption is that a text which describes a sequence of events will devote more space to more important events (for example, a period of war or an unrest will have much more space devoted to than a period of peaceful, non-eventful years), and that this irregularity will remain visible in other descriptions of the period. For each analysed text, a function is devised which maps each year mentioned in the text with the number of pages (lines, letters) devoted in the text to its description (which could be zero). The function of the two texts are then compared.[7]

For example, Fomenko compares the contemporary history of Rome written by Titus Livius with a modern history of Rome written by Russian historian V. S. Sergeev, calculating that the two have high correlation, and thus that they describe the same period of history, which is undisputed[8]. He also compares modern texts which describe different periods, and calculates low correlation, as expected[8]. However, when he compares, for example, the ancient history of Rome and the medieval history of Rome, he calculates a high correlation, and concludes that ancient history of Rome is a copy of medieval history of Rome, thus clashing with mainstream accounts[9].

Statistical correlation of dynasties

In a somewhat similar manner, Fomenko compares two dynasties of rulers using statistical methods. First, he creates a database of rulers, containing relevant information on each of them. Then, he creates "survey codes" for each pair of the rulers, which contain a number which describes degree of the match of each considered property of two rulers. For example, one of the properties is the way of death: if two rulers were both poisoned, they get value of +1 in their property of the way of death; if one ruler was poisoned and another

killed in combat, they get –1; and if one was poisoned, and another died of illness, they get 0 (there is possibility that chroniclers were not impartial and that different descriptions nonetheless describe the same person). An important property is the length of the rule.

Fomenko lists a number of pairs of seemingly unrelated dynasties – for example, dynasties of kings of Old Israel and emperors of late Western Roman Empire (300-476 A.D.) – and claims that this method demonstrates correlations between their reigns… He also claims that the regnal history of the 17th-20th centuries never shows correlation of "dynastic flows" with each other, therefore Fomenko insists history was multiplied and outstretched into imaginary antiquity to justify this or other "royal" pretensions.

Astronomical evidence

Fomenko examines astronomical events described in ancient texts and suggests that the chronology is actually medieval. For example:

• He associates the Star of Bethlehem with the 1054 A.D. supernova (now Crab Nebula) and the Crucifixion Eclipse with the total solar eclipse of 1086 A.D.. Such a pair of astronomical events separated by 32 years (the approximate age of Jesus at the time of his death) is extremely rare.

• He argues that the star catalog in the *Almagest,* ascribed to the Hellenistic astronomer Claudius Ptolemy, was actually created between 600 and 1300 A.D..

• He refines Morozov's analysis of some ancient horoscopes, most notably, the so-called Dendera Zodiacs – two horoscopes drawn on the ceiling of the temple of Hathor – and comes to the conclusion that they correspond to either the 11th and 13th centuries A.D.. Traditional history usually either interprets these horoscopes as belonging to the 1st century B.C. or suggests that they weren't meant to match any date at all.

• In his final analysis of an eclipse triad described by the ancient Greek Thucydides in *History of the Peloponnesian War*, Fomenko dates the eclipses to 1039, 1046 and 1057 A.D. Because of the layered structure of the manuscript, he concludes that Thucydides actually lived in medieval times and in describing the Peloponnesian War between the Spartans and Athenians he was actually describing the conflict between the medieval Navarrans and Catalans in Greece from 1374 to 1387 A.D.

Rejection of common dating methods

Dendrochronology is rejected on the basis that it, for dating of objects much older than the oldest still living trees, isn't an absolute, but a relative dating method, and thus dependent on traditional chronology; Fomenko specifically points to a break of dendrochronological scales around 1000 A.D.[10].

Fomenko also cites a number of cases where (now obsolete) carbon dating results on objects of known age gave significantly different dates before calibration of the radiocarbon dating scale. He also alleges undue cooperation between physicists and archaeologists in obtaining the dates, since most radiocarbon dating labs only accept samples with an age estimate suggested by historians or archaeologists. Fomenko also claims that carbon dating over the range of 0 to 2000 A.D. is inaccurate because it has too many sources of error that are either guessed at or completely ignored, and that calibration is done with a statistically meaningless number of samples[11]. Consequently, Fomenko concludes that carbon dating is not accurate enough to be used on historical scale. See here for an expanded discussion of Fomenko's assertions about archaeological, dendrochronological, and radiocarbon dating.

Popularity

Despite criticism, Fomenko has published and sold millions of copies of his books in his native Russia. The list of his supporters includes such famous figures as former Chess World champion Garry Kasparov. Kasparov met with Fomenko during the 1990s, and found that Fomenko's conclusions concerning certain subjects were the same as his own. Specifically, regarding what is called the Dark Ages, Kasparov was incredulous towards the commonly held notion that art and culture died and were not revived until the Renaissance. Kasparov also felt it illogical that the Romans living under the banner of Byzantium could fail to use the mounds of scientific knowledge left them by Ancient Greece and Rome, especially when it was of urgent military use.[12] Fomenko's theories became accessible to the Western public with the publication of the first two volumes of the seven volumes series *History: Fiction Or Science?* vol. 1 and vol. 2 in English.

The *Criticisms* part can be found on WIKIPEDIA, type **New Chronology Fomenko** in the serach window.

Thank you for your time.

The complete bibliography to the seven volumes

Separate books on the New Chronology

Prior to the publication of the seven-volume ***Chronology,*** we published a number of books on the same topic. If we are to disregard the paperbacks and the concise versions, as well as new re-editions, there are seven such books. Shortened versions of their names appear below:

1) ***Introduction***
2) ***Methods 1-2***
3) ***Methods 3***
4) ***The New Chronology of Russia, Britain and Rome***
5) ***The Empire***
6) ***The Biblical Russia***
7) ***Reconstruction***

Book one. ***Introduction.***

[Intro]:1. Fomenko, A. T. *New Experimental Statistical Methods of Dating Ancient Events and their Application to the Global Classical and Mediaeval Chronology.* Preprint. Moscow, The State Television and Radio Broadcast Committee, 1981. Order # 3672. Lit. 9/XI-81. No. BO7201, 100 p.

[Intro]:2. Fomenko, A. T. *Some New Empirico-Statistical Methods of Dating and the Analysis of Present Global Chronology.* London, The British Library, Department of Printed Books, 1981. Cup. 918/87. 100 p.

[Intro]:3. Fomenko, A. T. *A Criticism of the Traditional Chronology of the Classical Age and the Middle Ages (What Century Is It Now?).* Essay. Moscow, Publishing House of the Moscow State University Department of Mechanical Mathematics, 1993. 204 p.

[Intro]:4. 2nd edition, revised and expanded. Fomenko, A. T., and G. V. Nosovskiy. *A Criticism of the Traditional Chronology of the Classical Age and the Middle Ages (What Century Is It Now?).* Moscow, Kraft-Lean, 1999. 757 p. Kraft Publications released a concise version of this book in 2001. 487 p.

[Intro]:5. Another revision. Fomenko, A. T., and G. V. Nosovskiy. *What Century Is It Now?* Moscow, AIF-Print Publications, 2002. 511 p.

Book two, part one: ***Methods-1.***

[Meth1]:1. Fomenko, A. T. *The Methods of Statistical Analysis of Narrative Texts and their Chronological Applications.* (The identification and dating of dependent texts, statistical chronology of the antiquity, as well as the statistics of ancient astronomical accounts.) Moscow, The MSU Publishing House, 1990. 439 p.

[Meth1]:2. 2nd revised edition came out in 1996 as *The Methods Of Mathematical Analysis of Historical Texts. Chronological applications.* Moscow, Nauka Publications, 1996. 475 p.

[Meth1]:3. Several chapters of the book came out in 1996, revised and extended, as a separate book: Fomenko, A. T. *The New Chronology of Greece. Antiquity in the Middle Ages,* Vols. 1 and 2. Moscow, MSU Centre of Research and Pre-University Education, 1996. 914 p.

[Meth1]:4. The English translation of the book, extended and revised to a large extent, was released under the following title: Fomenko, A. T. *Empirico-Statistical Analysis of Narrative Material and its Applications to Historical Dating.* Vol. 1, *The Development of the Statistical Tools.* Vol. 2, *The Analysis of Ancient and Mediaeval Records.* The Netherlands, Kluwer Academic Publishers, 1994. Vol. 1: 211 p. Vol. 2: 462 p.

[Meth1]:5. A Serbian translation titled *Фоменко А.Т. Статистичка хронологиjа. Математички поглед на историjу. У ком смо веку?* was published in 1997. Belgrade, Margo-Art, 1997. 450 p.

[Meth1]:6. The book was published in a revised and substantially extended version in 1999 as Volume 1 in a series of two: Fomenko, A. T. *The Methods of Statistical*

Analysis of Historical Texts. Chronological Applications. Vol. 1. Moscow, Kraft and Lean, 1999. 801 p.

[METH1]:7. A revised version of the book was published as two volumes (the first two in a series of three) in 1999 in the USA (in Russian) by the Edwin Mellen Press. Fomenko, A. T. *New Methods of Statistical Analysis of Historical Texts. Applications to Chronology,* Vols. 1 and 2. The publication is part of the series titled *Scholarly Monographs in the Russian Language,* Vols. 6-7. Lewiston, Queenston, Lampeter, The Edwin Mellen Press, 1999. Vol. 1: 588 p. Vol. 2: 564 p.

BOOK TWO, part two: ***Methods-2.***

[METH2]:1. Fomenko, A. T. *Global Chronology.* (A Research of the Classical and Mediaeval History. Mathematical Methods of Source Analysis. Global Chronology.) Moscow, MSU Publications, 1993. 408 p.

[METH2]:2. A revised and substantially extended version of the book as the second volume in a series of two: Fomenko, A. T. *The Methods of Statistical Analysis of Historical Texts. Chronological Applications,* Vol. 2. Moscow, Kraft and Lean, 1999. 907 p.

[METH2]:3. A revised version of the book was published as the last volume in a series of three in the USA (in Russian) under the title: Fomenko A. T. *Antiquity in the Middle Ages (Greek and Bible History),* the trilogy bearing the general name: Fomenko A. T. *New Methods of the Statistical Analysis of Historical Texts and their Chronological Application.* The publication is part of the series titled *Scholarly Monographs in the Russian Language.* Lewiston, Queenston, Lampeter, The Edwin Mellen Press, 1999. 578 p.

BOOK THREE: ***Methods-3.***

[METH3]:1. Fomenko, A. T., V. V. Kalashnikov, and G. V. Nosovskiy. *Geometrical and Statistical Methods of Analysis of Star Configurations. Dating Ptolemy's Almagest.* USA: CRC Press, 1993. 300 p.

[METH3]:2. The Russian version of the book was published in 1995 in Moscow by the Faktorial Publications under the title: Kalashnikov V. V., Nosovskiy G. V., Fomenko A. T. *The Dating of the Almagest Star Catalogue. Statistical and Geometrical Analysis.* 286 p.

[METH3]:3. A substantially extended and revised version of the book: Kalashnikov, V. V., G. V. Nosovskiy, and A. T. Fomenko. *The Astronomical Analysis of Chronology. The Almagest. Zodiacs.* Moscow, The Delovoi Express Financial Publications, 2000. 895 p.

[METH3]:4. Fomenko, A. T., and G. V. Nosovskiy. *The New Chronology of Egypt. The Astronomical Dating of Ancient Egyptian Monuments. Research of 2000-2002.* Moscow, Veche Press, 2002. 463 p.

BOOK FOUR: ***Russia, Britain and Rome.***

[RBR]:1. Fomenko, A. T., and G. V. Nosovskiy. *The New Chronology and Conception of the Ancient History of Russia, Britain, and Rome. Facts, Statistics, Hypotheses.* Vol. 1, *Russia.* Vol. 2, *Britain and Rome.* Moscow, MSU Centre of Research and Pre-University Education. Two editions, 1995 and 1996. 672 p.

[RBR]:2. A somewhat adapted and revised version of the book came out in 1997: Fomenko, A. T., and G. V. Nosovskiy. *Russia and Rome. How correct is our understanding of Eurasian history?* Vols. 1 and 2. Moscow, Olymp Publications, 1997. 2nd edition 1999. The next three volumes from this series of five were published in 2001. Vol. 1: 606 p. Vol. 2: 621 p. Vol. 3: 540 p. Vol. 4: 490 p. Vol. 5: 394 p.

[RBR]:3. A revised version of the first volume was published in 1997 as a separate book: Fomenko, A. T., and G. V. Nosovskiy. *The New Chronology of Russia.* Moscow, Faktorial Publications, 1997. Re-editions 1998 and 1999. 255 p.

[RBR]:4. A new, substantially extended and revised version of the first two-volume edition as a single volume: Fomenko, A. T., and G. V. Nosovskiy. *The New Chronology of Russia, Britain and Rome.* Moscow, Anvik, 1999. 540 p.

[RBR]:5. A new revised version of this book came out as a single volume: Fomenko A. T., and G. V. Nosovskiy. *The New Chronology of Russia, Britain and Rome.* Moscow, The Delovoi Express Financial Publications, 2001. 1015 p.

BOOK FIVE: ***The Empire.***

[EMP]:1. Fomenko, A. T., and G. V. Nosovskiy. *The Empire (Russia, Turkey, China, Europe, Egypt. The New Mathematical Chronology of Antiquity).* Moscow, Faktorial, 1996. Re-editions 1997, 1998, 1999, 2001 and 2002. 752 p.

BOOK SIX: ***The Biblical Russia.***

[BR]:1. Fomenko, A. T., and G. V. Nosovskiy. *The Mathematical Chronology of the Biblical Events.* Moscow, Nauka Publications, 1997. 407 p.

[BR]:2. A substantially revised and extended version: Fomenko, A. T., and G. V. Nosovskiy. *The Biblical Russia. The Empire of Horde-Russia and the Bible. The New Mathematical Chronology of Antiquity.* Vols. 1 and 2. Moscow, Faktorial, 1998. Vol. 1: 687 p. Vol. 2: 582 p.

[BR]:3. A somewhat condensed version, which nevertheless contained some important new material: Fomenko, A. T., and G. V. Nosovskiy. *Horde-Russia on the Pages of the Biblical Books.* Moscow, Anvik Publications, 1998. 430 p.

[BR]:4. Fomenko, A. T., and G. V. Nosovskiy. *The Biblical Russia. Selected Chapters I (The Empire of Horde-Russia and the Bible. The New Mathematical Chronology of Antiquity. History of the Manuscripts and Editions of the Bible. The Events of the XI-XII Century A.D. in the New*

Testament. The Pentateuch.). Moscow, Faktorial, 1999. 173 p.

[BR]:5. Fomenko, A. T., and G. V. Nosovskiy. *The Biblical Russia. Selected Chapters II (The Empire of Horde-Russia and the Bible. The New Mathematical Chronology of Antiquity. History of the XIV-XVI Century in the Last Books of the Kings. The History of the XV-XVI Century in the Last Chapters of the Books of the Kings. History of the XV-XVI Century in the Books of Esther and Judith. The Reformation Epoch of the XVI-XVII Century).* Moscow, Faktorial Press, 2000. 223 p.

BOOK SEVEN: ***Reconstruction.***

[REC]:1. Fomenko, A. T., and G. V. Nosovskiy. *A Reconstruction of Global History (The New Chronology).* Book 1. Moscow, The Delovoi Express Financial Publishers, 1999. 735 p.

[REC]:2. Fomenko, A. T., and G. V. Nosovskiy. *A Reconstruction of Global History. The Research of 1999-2000 (The New Chronology).* Moscow, The Delovoi Express Financial Publishers, 1999. 615 p.

[REC]:3. Fomenko, A. T., and G. V. Nosovskiy. *A Reconstruction of Global History. Joan of Arc, Samson, and the History of Russia.* Moscow, The Delovoi Express Financial Publishers, 2002.

We have to point out that the publication of our books on the New Chronology has influenced a number of authors and their works where the new chronological concepts are discussed or developed. Some of these are: L. I. Bocharov, N. N. Yefimov, I. M. Chachukh, and I. Y. Chernyshov ([93]), Jordan Tabov ([827], [828]), A. Goutz ([220]), M. M. Postnikov ([680]), V. A. Nikerov ([579:1]), Heribert Illig ([1208]), Christian Blöss and Hans-Ulrich Niemitz ([1038], [1039]), Gunnar Heinsohn ([1185]), Gunnar Heinsohn and Heribert Illig ([1186]), Uwe Topper ([1462], [1463]).

Our research attracted sufficient attention to chronological issues for the Muscovite publishing house Kraft to print a new edition of the fundamental work of N. A. Morozov titled ***Christ,*** first published in 1924-1932.

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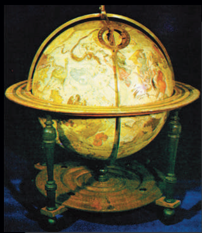

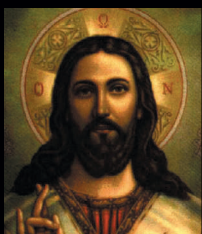

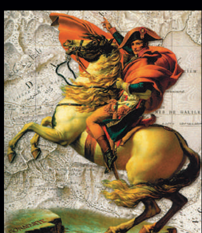

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